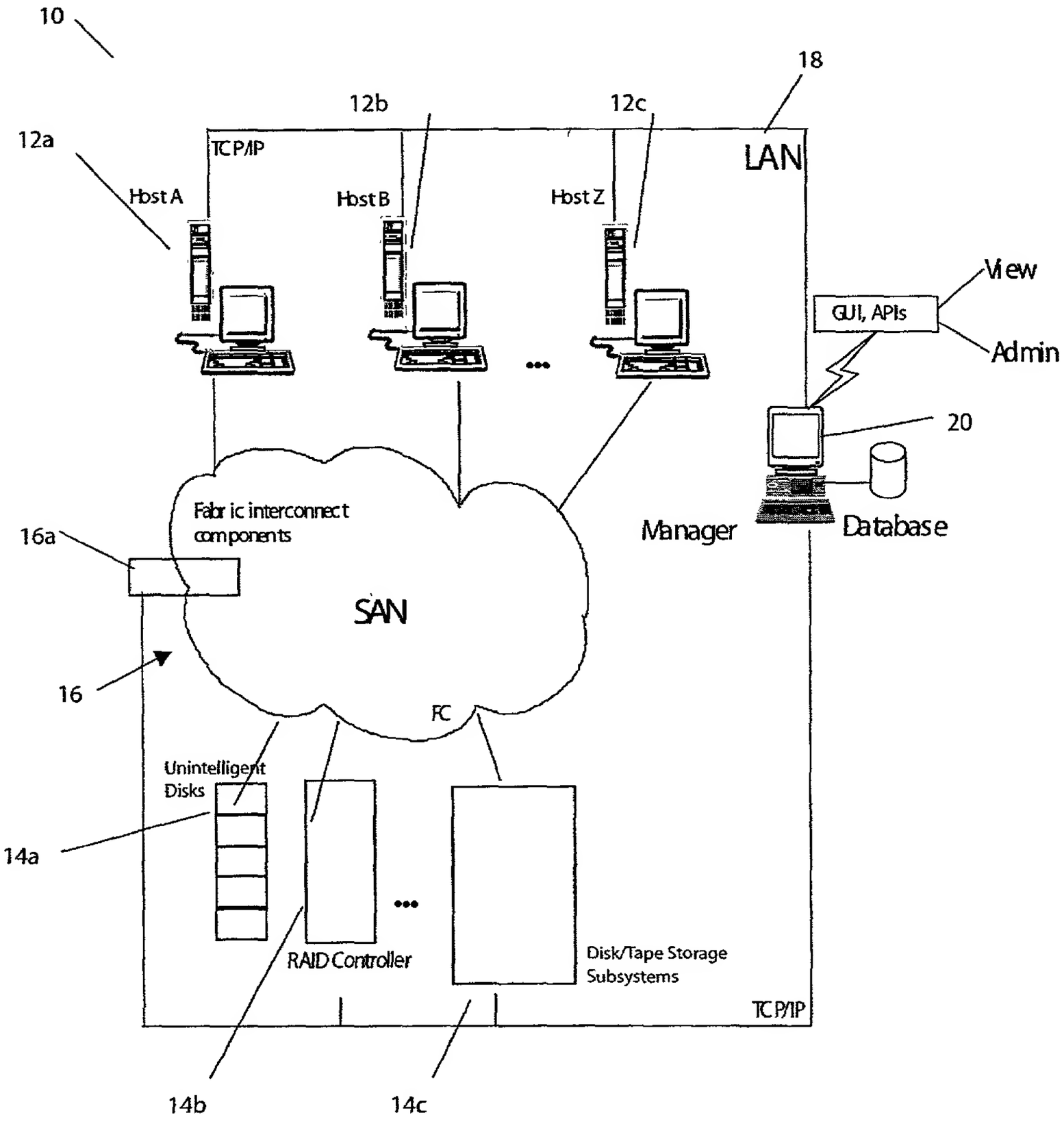

10
18
12b
12c
12a
TCP/IP
LAN
Host A
Host B
Host Z
View
GUI, APIs
Admin
20
Fabric interconnect components
16a
SAN
Manager
Database
16
FC
Unintelligent Disks
14a
RAID Controller
Disk/Tape Storage Subsystems
TCP/IP
14b
14c

Figure 1

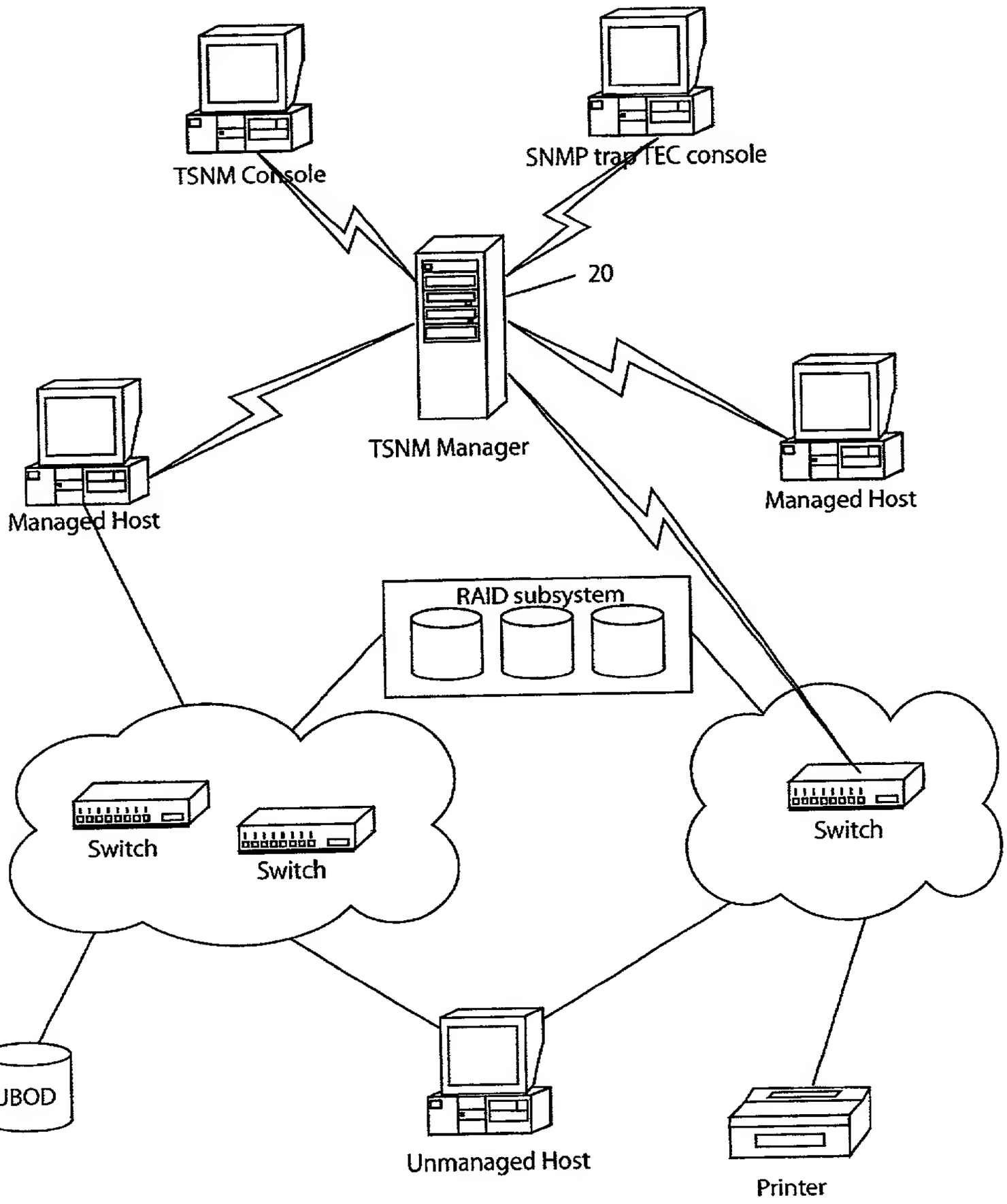

TSNM Console
SNMP trap TEC console
20
TSNM Manager
Managed Host
Managed Host
RAID subsystem
Switch
Switch
Switch
JBOD
Unmanaged Host
Printer

Figure 2

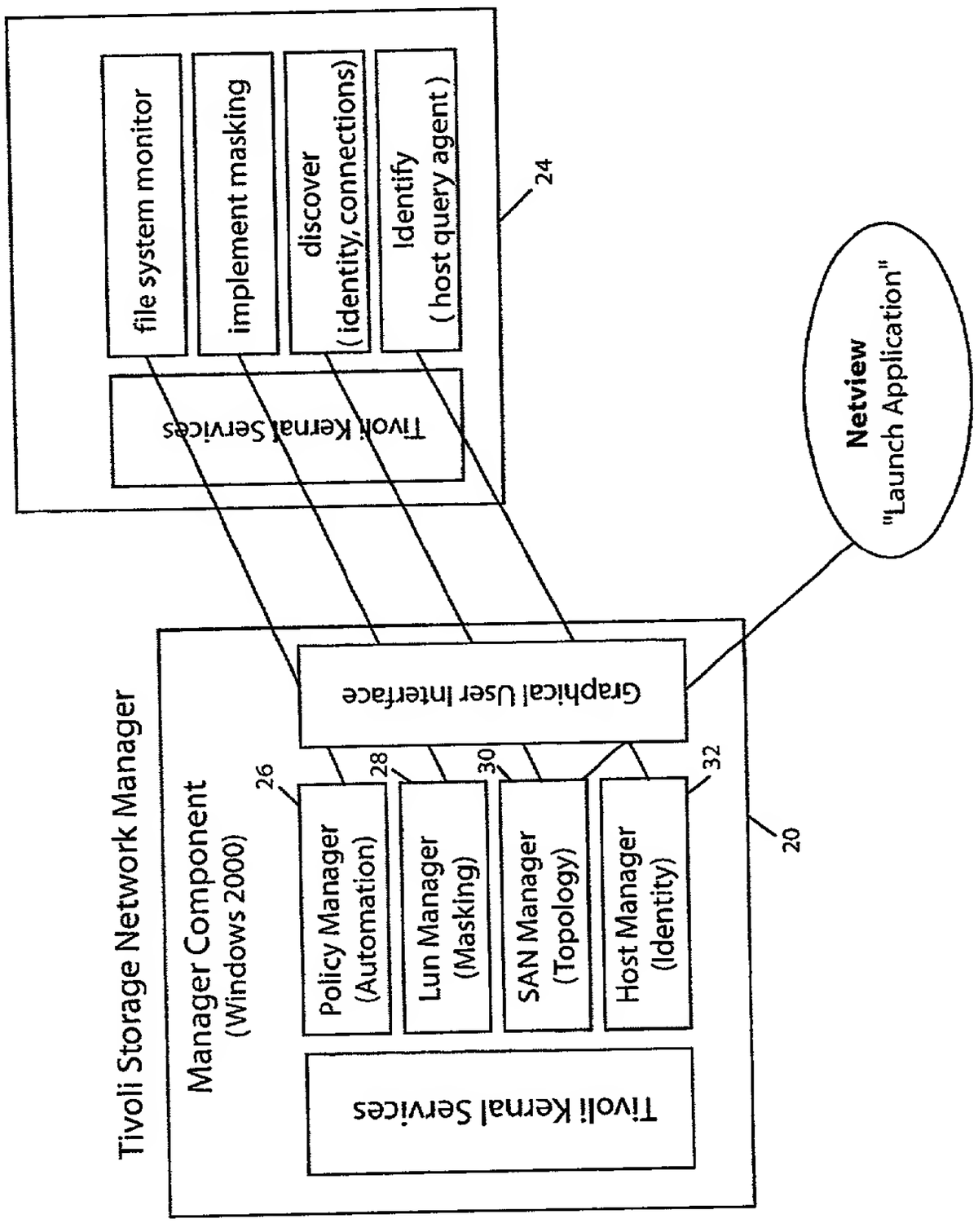
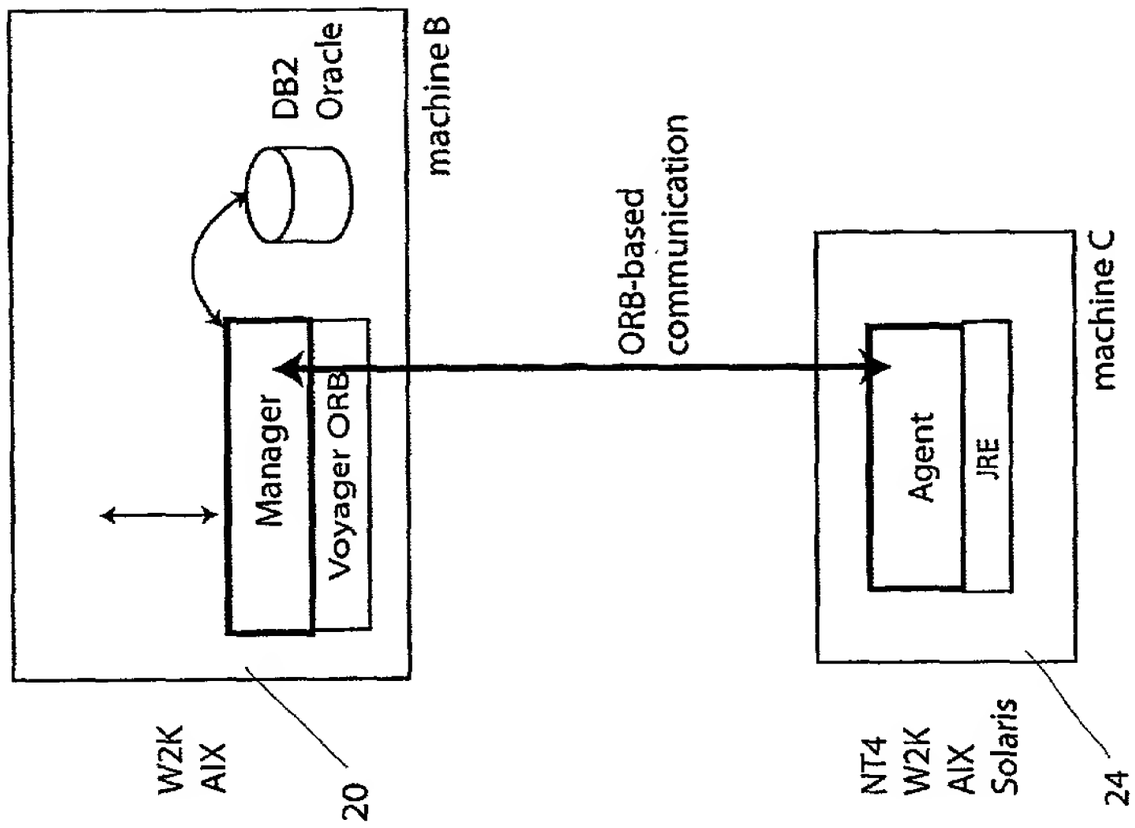

Tivoli Storage Network Manager
Manager Component
(Windows 2000)
Tivoli Kernal Services
Policy Manager
(Automation)
Lun Manager
(Masking)
SAN Manager
(Topology)
Host Manager
(Identity)
Graphical User Interface
20
26
28
30
32
Tivoli Kernal Services
file system monitor
implement masking
discover
(identity, connections)
Identify
(host query agent)
24
Netview
"Launch Application"

Figure 3

Figure 4


Manager & Agent communication
W2K
AIX
20
Manager
Voyager ORB
DB2
Oracle
machine B
ORB-based
communication
NT4
W2K
AIX
Solaris
24
Agent
JRE
machine C

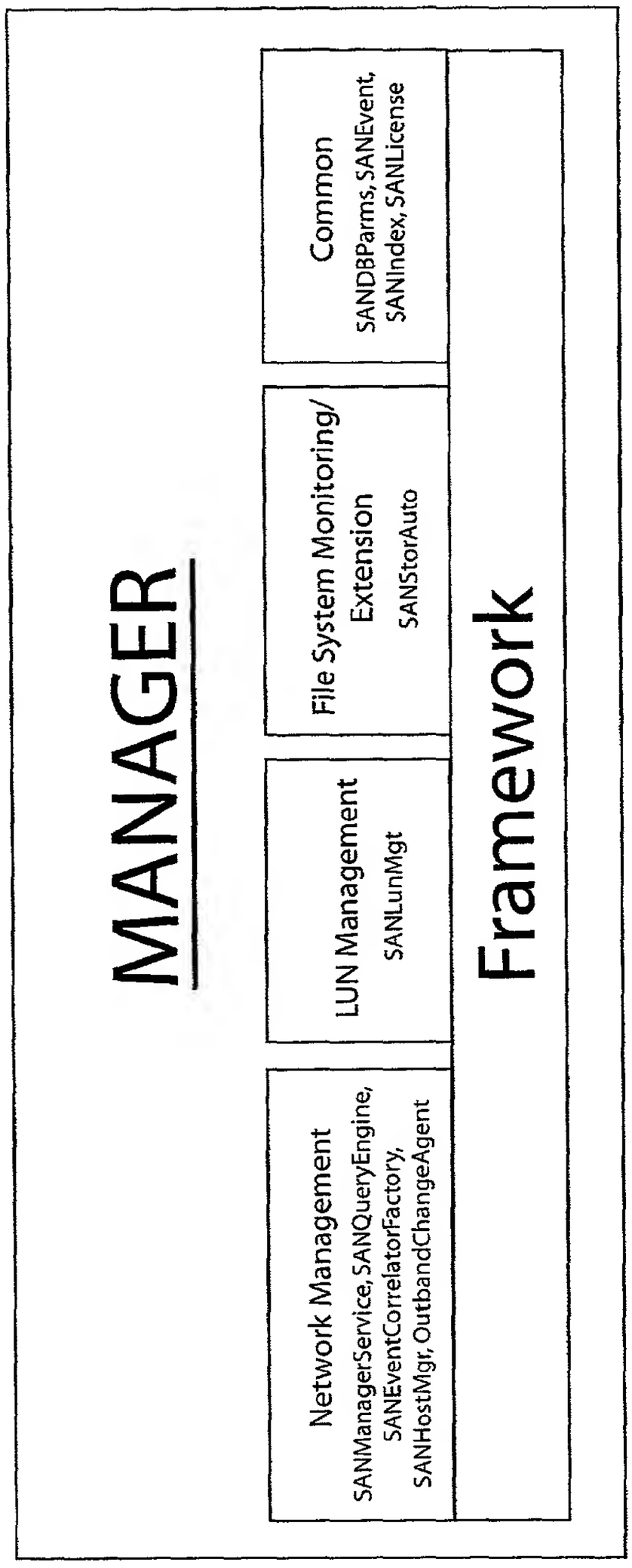

MANAGER
Framework
Common
SANDBParms, SANEvent, SANIndex, SANLicense
LUN Management
SANLunMgt
File System Monitoring/ Extension
SANStorAuto
Network Manage
SANManagerService, SANQ
SANEventCorrelatorFa
SANHostMgr, OutbandCha

Figure 5

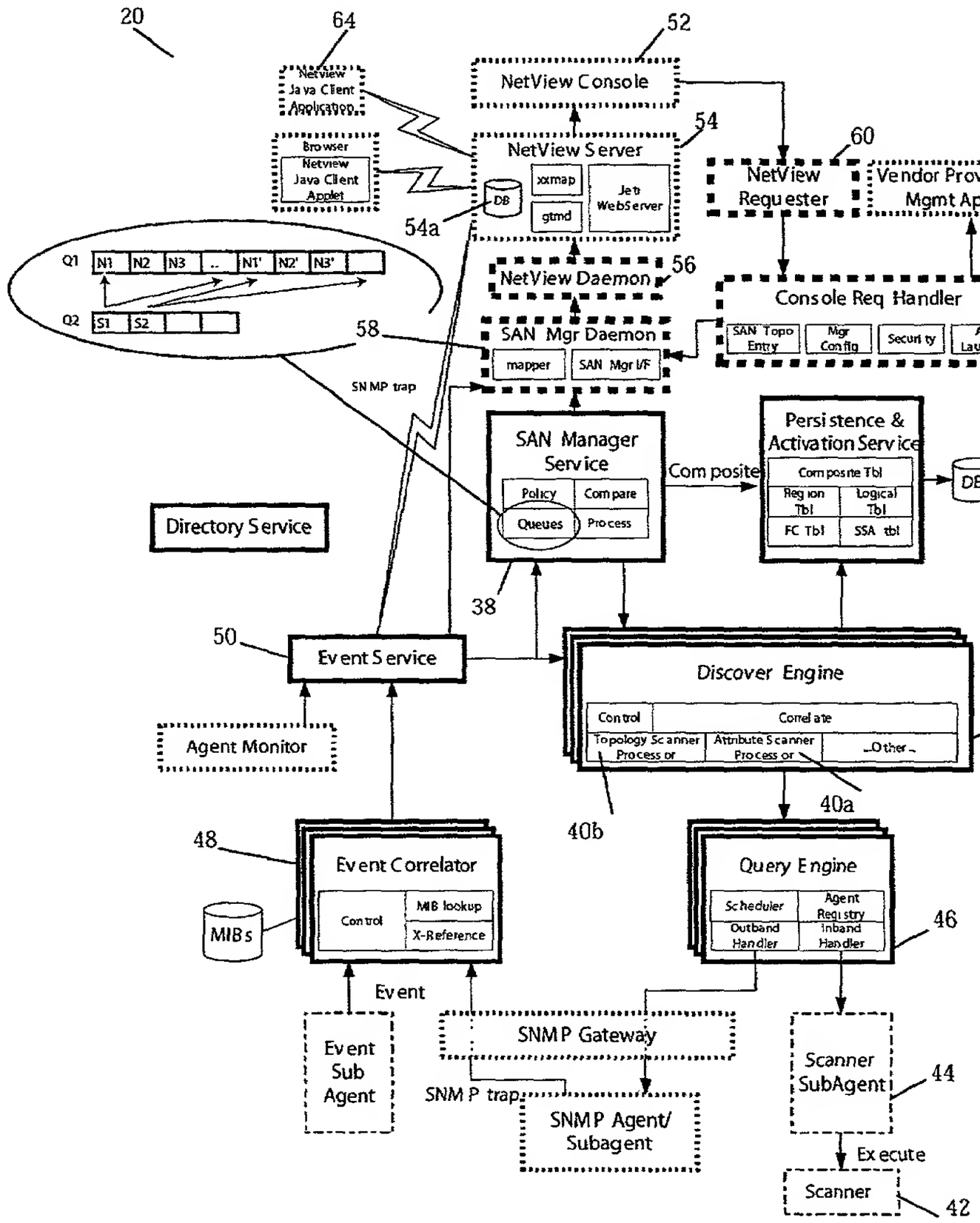

20
64
52
Netview Java Client Application
NetView Console
Browser
Netview Java Client Applet
54
NetView Server
xxmap
gtmd
Jetr WebServer
DB
54a
60
NetView Requester
Vendor Provided Mgmt App
Q1
N1
N2
N3
..
N1'
N2'
N3'
Q2
S1
S2
NetView Daemon
56
Console Req Handler
62
SAN Topo Entry
Mgr Config
Security
App Launcher
58
SAN Mgr Daemon
mapper
SAN Mgr I/F
SNMP trap
SAN Manager Service
Policy
Compare
Queues
Process
Composite
Persistence & Activation Service
Composite Tbl
Region Tbl
Logical Tbl
FC Tbl
SSA tbl
DB
Directory Service
38
50
Event Service
Discover Engine
Control
Correlate
Topology Scanner Processor
Attribute Scanner Processor
Other
40
40a
40b
Agent Monitor
48
Event Correlator
Control
MIB lookup
X-Reference
MIBs
Query Engine
Scheduler
Agent Registry
Outband Handler
Inband Handler
46
Event
Event Sub Agent
SNMP Gateway
SNMP trap
SNMP Agent/ Subagent
Scanner SubAgent
44
Execute
Scanner
42

Figure 6

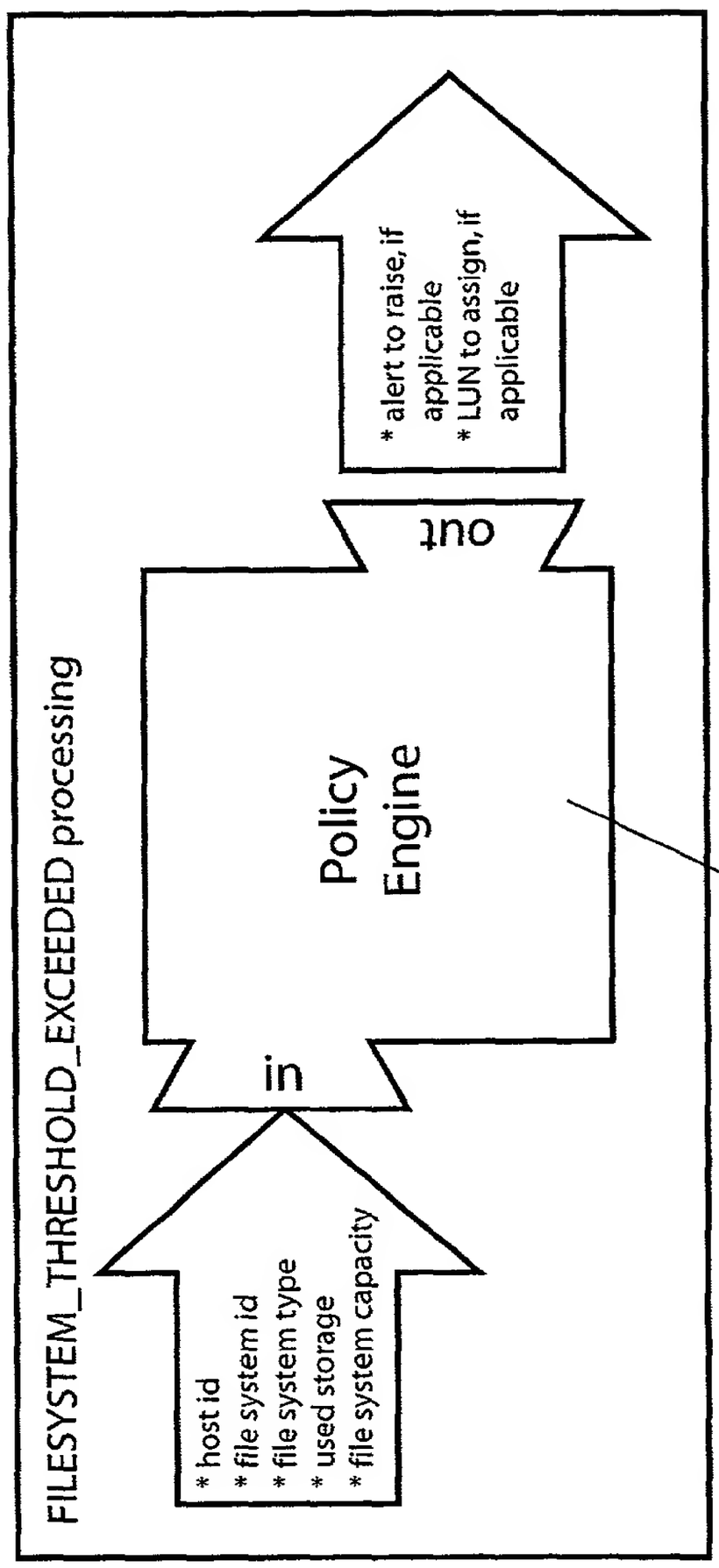

FILESYSTEM_THRESHOLD_EXCEEDED processing
* host id
* file system id
* file system type
* used storage
* file system capacity
in
Policy Engine
out
* alert to raise, if applicable
* LUN to assign, if applicable
38a

Figure 7A

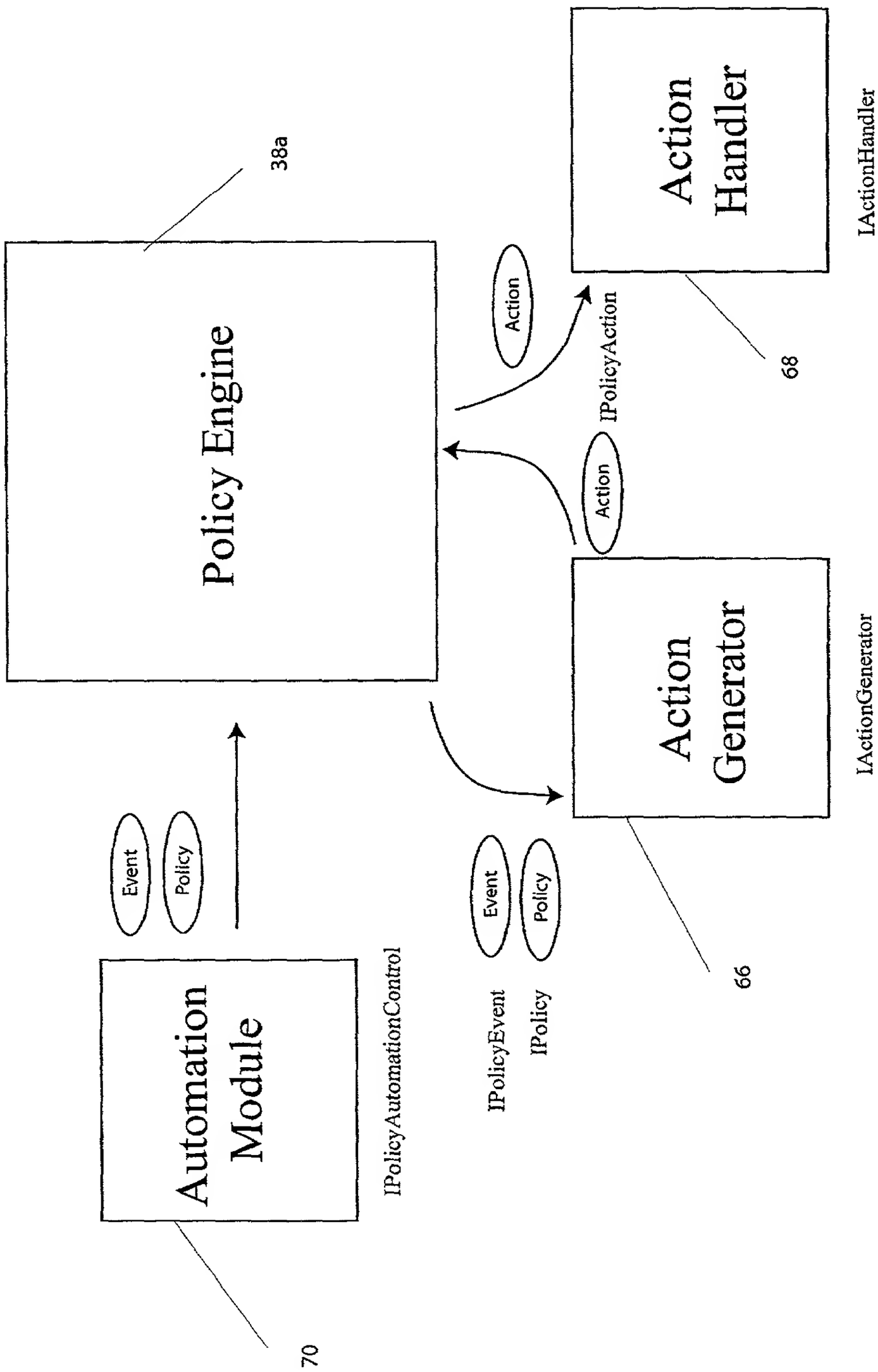

Policy Engine
38a
Action Handler
IActionHandler
Action
IPolicyAction
68
Action
Action Generator
IActionGenerator
Event
Policy
IPolicyEvent
IPolicy
66
Event
Policy
Automation Module
IPolicyAutomationControl
70

Figure 7B

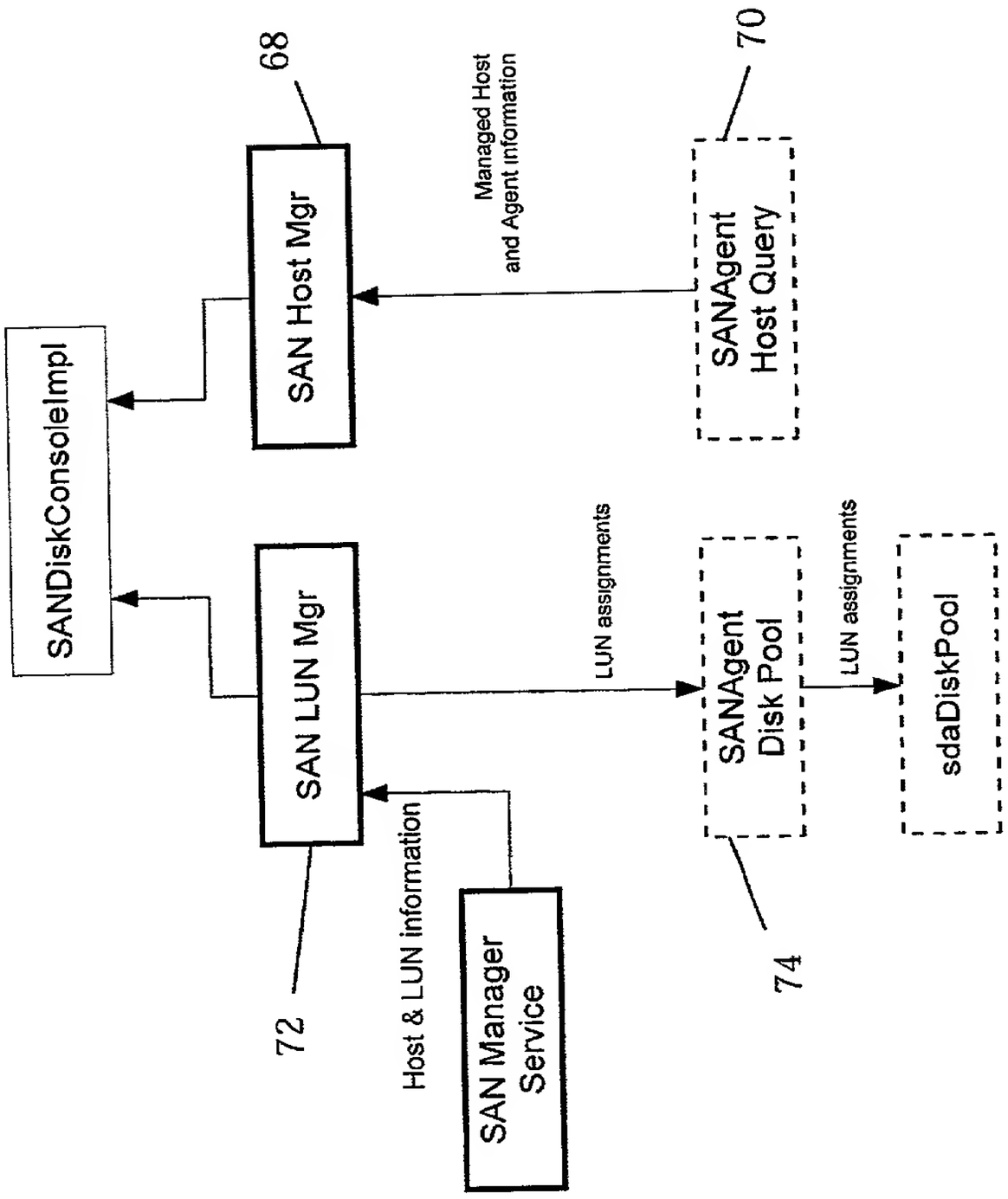

68
70
SANDiskConsoleImpl
SAN Host Mgr
SAN LUN Mgr
SAN Manager Service
SANAgent Host Query
SANAgent Disk Pool
sdaDiskPool
LUN assignments
LUN assignments
Host & LUN information
72
74

Figure 8

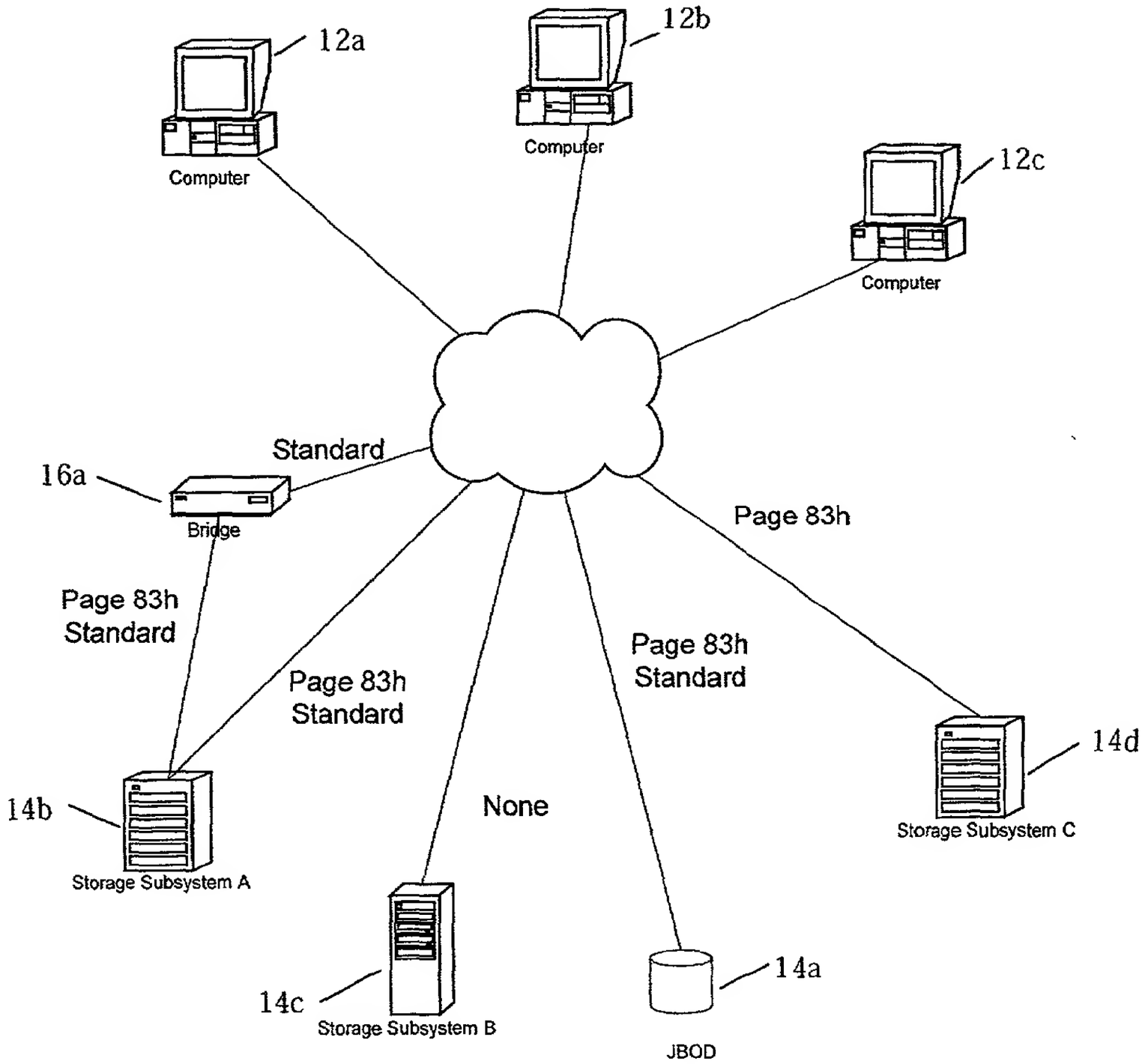
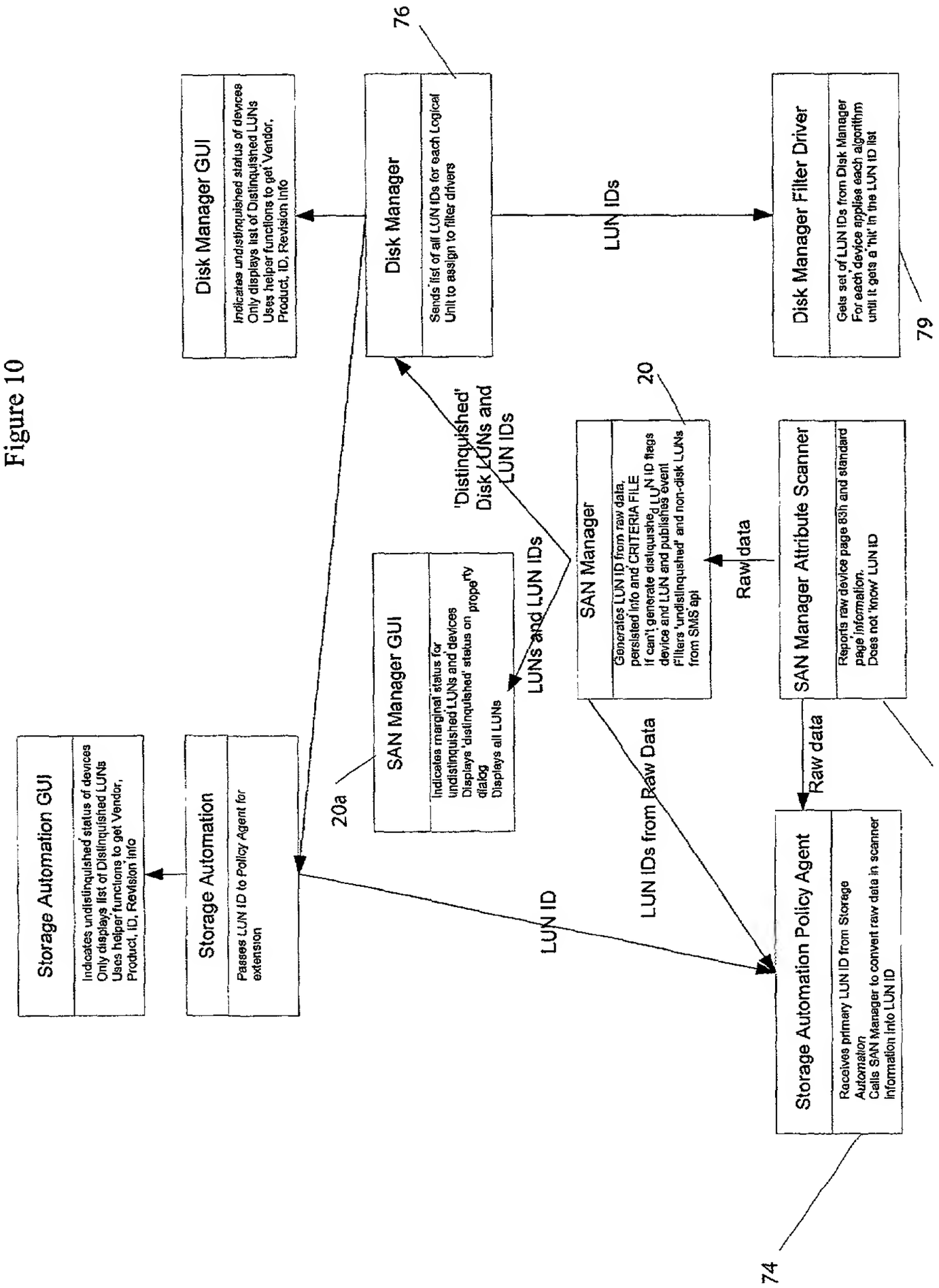

12a
Computer
12b
Computer
12c
Computer
Standard
16a
Bridge
Page 83h
Page 83h
Standard
Page 83h
Standard
Page 83h
Standard
Page 83h
14b
Storage Subsystem A
None
14c
Storage Subsystem B
14a
JBOD
14d
Storage Subsystem C

Figure 9

Figure 10


Disk Manager GUI
Indicates undistinguished status of devices
Only displays list of Distinguished LUNs
Uses helper functions to get Vendor, Product, ID, Revision info
Disk Manager
Sends list of all LUN IDs for each Logical Unit to assign to filter drivers
76
LUN IDs
Disk Manager Filter Driver
Gets set of LUN IDs from Disk Manager
For each device applies each algorithm until it gets a 'hit' in the LUN ID list
79
'Distinguished' Disk LUNs and LUN IDs
20
SAN Manager
Generates LUN ID from raw data, persisted info and CRITERIA FILE
If can't generate distquished LUN ID flags device and LUN and publishes event
Filters 'undistinquished' and non-disk LUNs from SMS api
Raw data
SAN Manager Attribute Scanner
Reports raw device page 83h and standard page information.
Does not 'know' LUN ID
42A
LUNs and LUN IDs
20a
SAN Manager GUI
Indicates marginal status for undistinguished LUNs and devices
Displays 'distinquished' status on property dialog
Displays all LUNs
LUN IDs from Raw Data
LUN ID
Storage Automation GUI
Indicates undistinquished status of devices
Only displays list of Distinquished LUNs
Uses helper functions to get Vendor, Product, ID, Revision info
Storage Automation
Passes LUN ID to Policy Agent for extension
Raw data
Storage Automation Policy Agent
Receives primary LUN ID from Storage Automation
Calls SAN Manager to convert raw data in scanner information into LUN ID
74

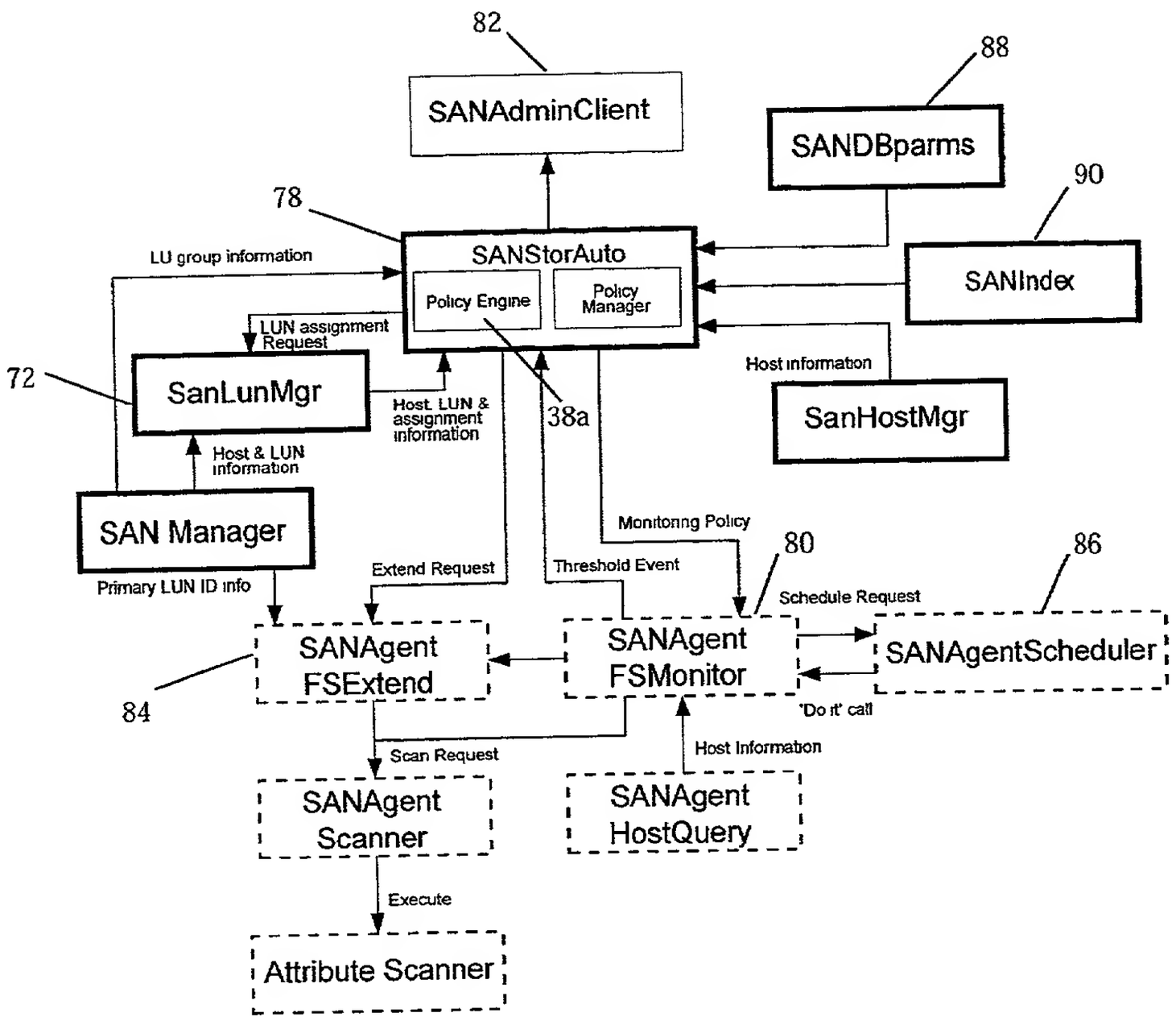

82
SANAdminClient
88
SANDBparms
90
78
SANStorAuto
Policy Engine
Policy Manager
SANIndex
LU group information
LUN assignment Request
72
SanLunMgr
Host, LUN & assignment information
38a
Host information
SanHostMgr
Host & LUN information
SAN Manager
Monitoring Policy
80
86
Primary LUN ID info
Extend Request
Threshold Event
Schedule Request
SANAgent FSExtend
SANAgent FSMonitor
SANAgentScheduler
84
'Do it' call
Scan Request
Host Information
SANAgent Scanner
SANAgent HostQuery
Execute
Attribute Scanner

Figure 11

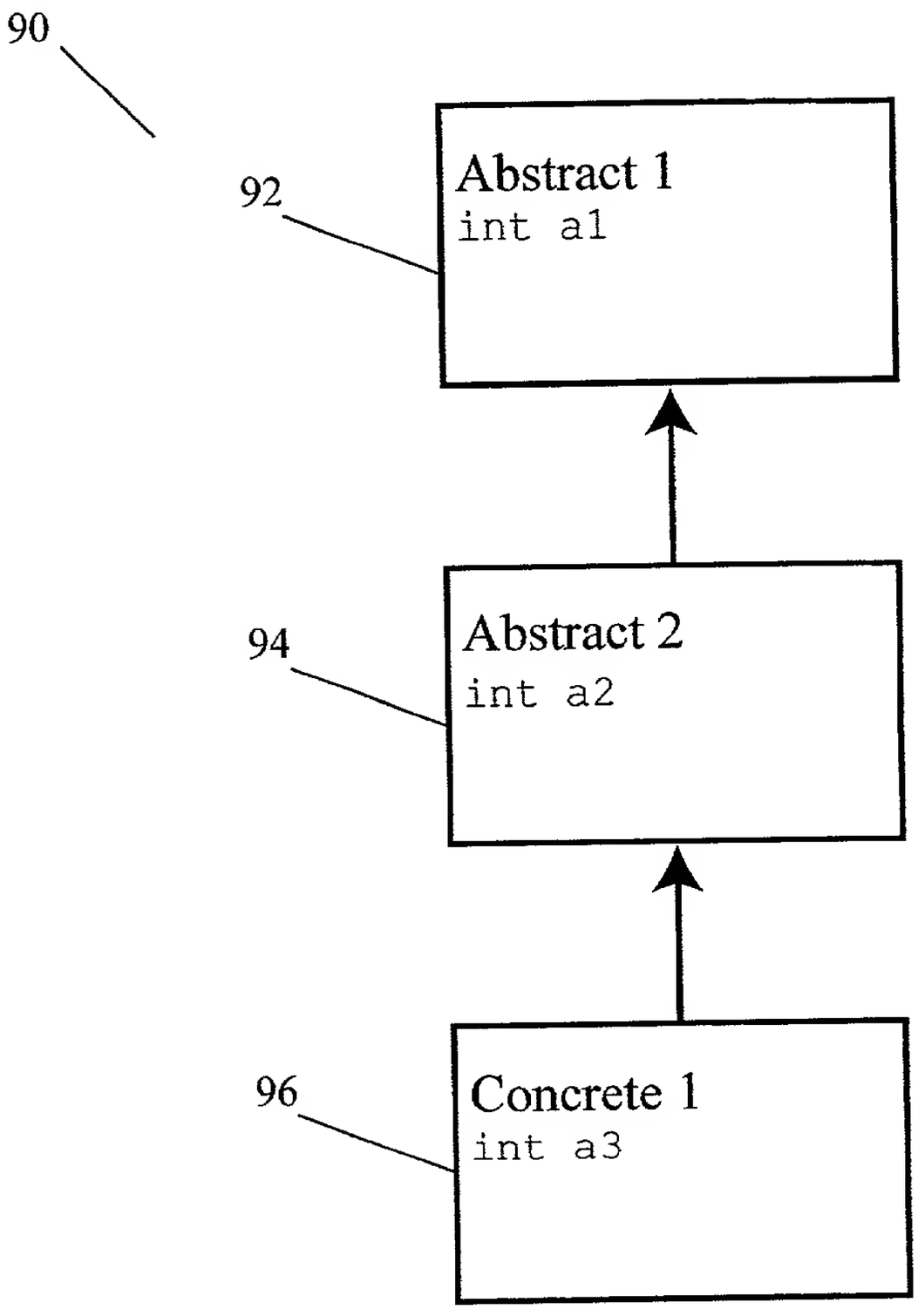

90
92
Abstract 1
int a1
94
Abstract 2
int a2
96
Concrete 1
int a3

Figure 12

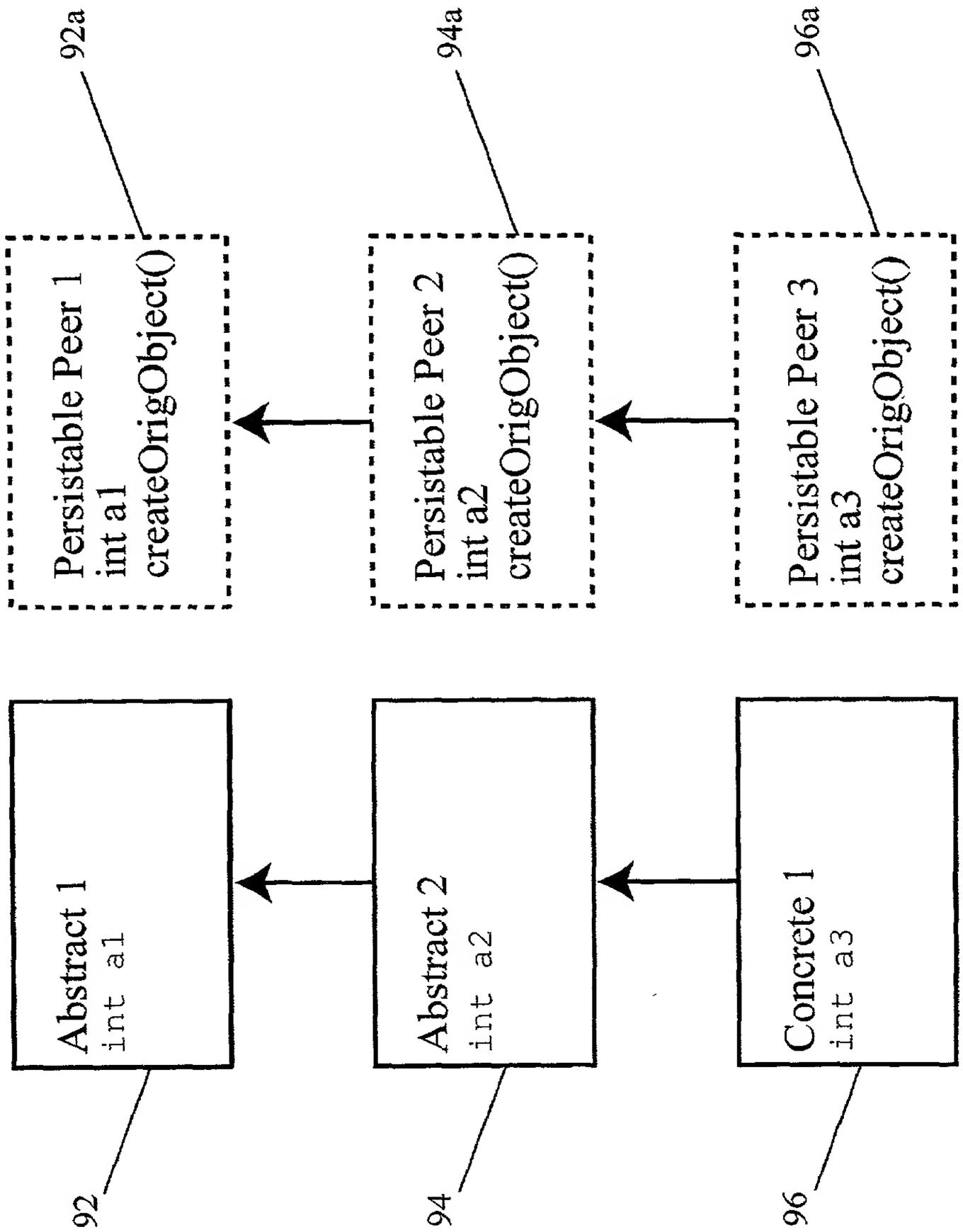

92a
94a
96a
Persistable Peer 1
int a1
createOrigObject
Persistable Peer 2
int a2
createOrigObject
Persistable Peer 3
int a3
createOrigObject
Abstract 1
int a1
Abstract 2
int a2
Concrete 1
int a3
92
94
96

Figure 13

Figure 14a

Figure 14b

Figure 14c

Figure 14d

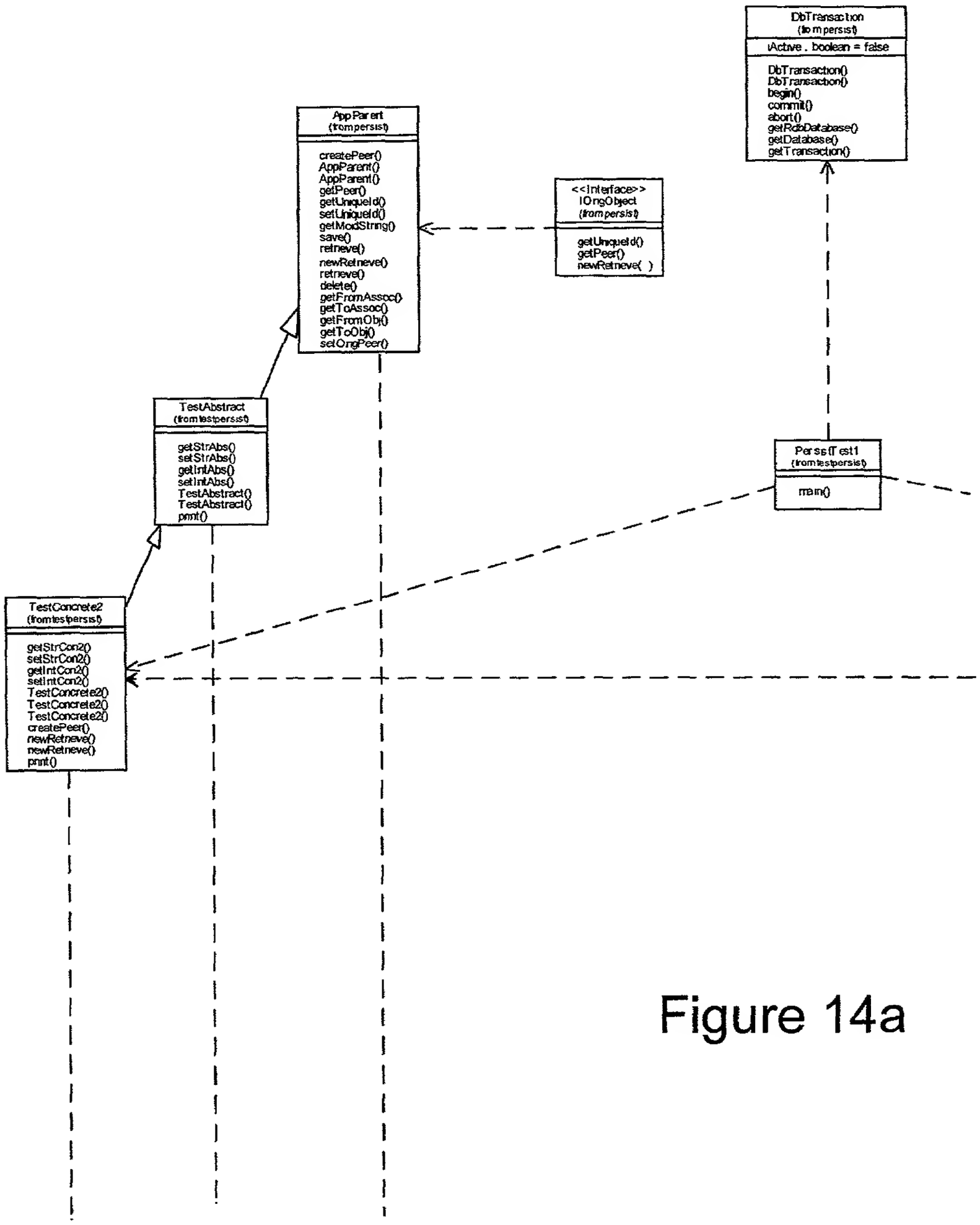

DbTransaction
(frompersist)
iActive . boolean = false
DbTransaction()
DbTransaction()
begin()
commit()
abort()
getRdbDatabase()
getDatabase()
getTransaction()
AppParent
(frompersist)
createPeer()
AppParent()
AppParent()
getPeer()
getUniqueId()
setUniqueId()
getModString()
save()
retrieve()
newRetrieve()
retrieve()
delete()
getFromAssoc()
getToAssoc()
getFromObj()
getToObj()
setOrgPeer()
<<Interface>>
IOrgObject
(frompersist)
getUniqueId()
getPeer()
newRetrieve( )
TestAbstract
(fromtestpersist)
getStrAbs()
setStrAbs()
getIntAbs()
setIntAbs()
TestAbstract()
TestAbstract()
print()
PerssTest1
(fromtestpersist)
main()
TestConcrete2
(fromtestpersist)
getStrCon2()
setStrCon2()
getIntCon2()
setIntCon2()
TestConcrete2()
TestConcrete2()
TestConcrete2()
createPeer()
newRetrieve()
newRetrieve()
print()

Figure 14a

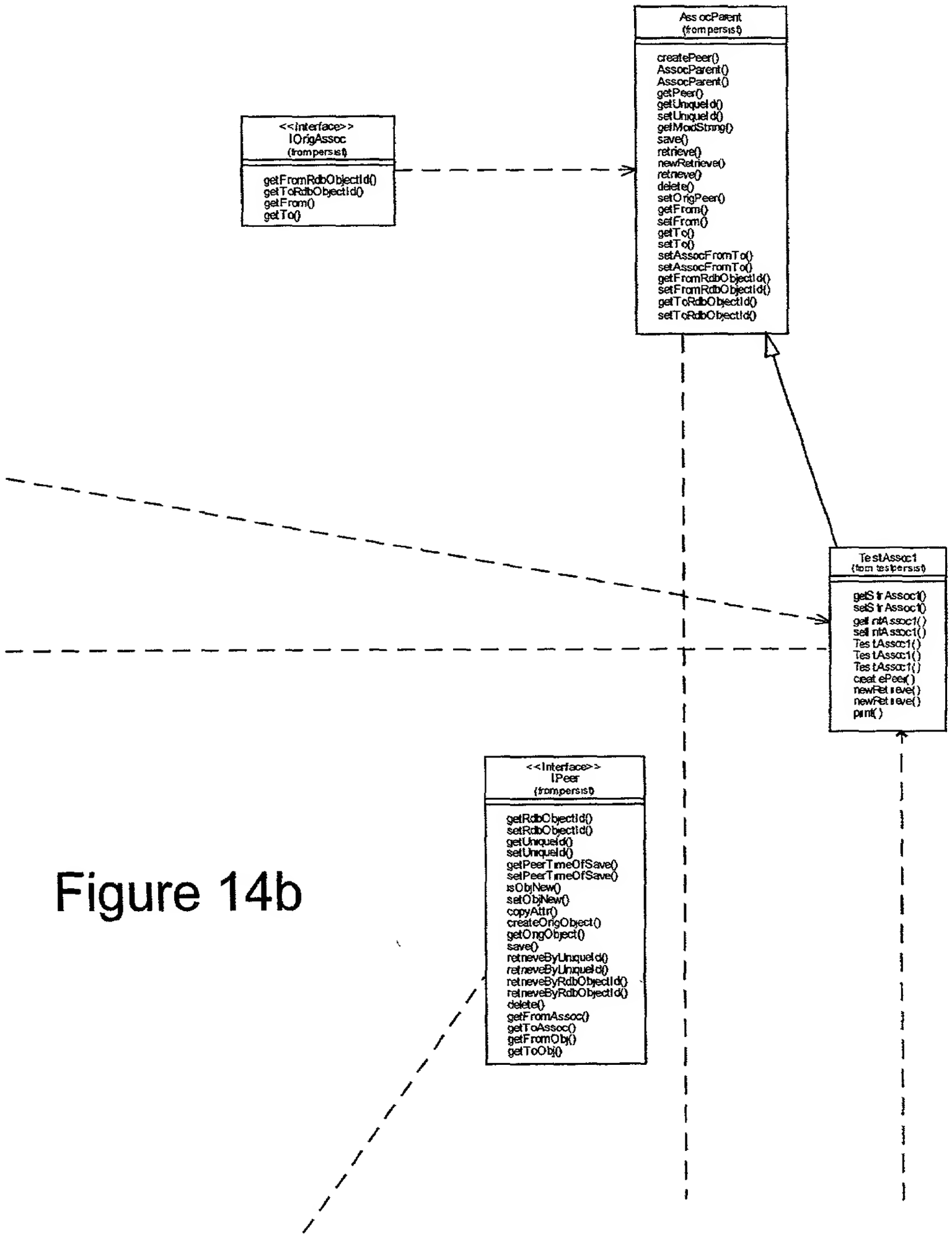

<<Interface>>
IOrigAssoc
(frompersist)
getFromRdbObjectId()
getToRdbObjectId()
getFrom()
getTo()
AssocParent
(frompersist)
createPeer()
AssocParent()
AssocParent()
getPeer()
getUniqueId()
setUniqueId()
getModString()
save()
retrieve()
newRetrieve()
retreve()
delete()
setOrigPeer()
getFrom()
setFrom()
getTo()
setTo()
setAssocFromTo()
setAssocFromTo()
getFromRdbObjectId()
setFromRdbObjectId()
getToRdbObjectId()
setToRdbObjectId()
TestAssoc1
(from testpersist)
getStrAssoc1()
setStrAssoc1()
getIntAssoc1()
setIntAssoc1()
TestAssoc1()
TestAssoc1()
TestAssoc1()
createPeer()
newRetrieve()
newRetrieve()
print()
<<Interface>>
IPeer
(frompersist)
getRdbObjectId()
setRdbObjectId()
getUniqueId()
setUniqueId()
getPeerTimeOfSave()
setPeerTimeOfSave()
isObjNew()
setObjNew()
copyAttr()
createOrigObject()
getOrgObject()
save()
retreveByUniqueId()
retreveByUniqueId()
retreveByRdbObjectId()
retreveByRdbObjectId()
delete()
getFromAssoc()
getToAssoc()
getFromObj()
getToObj()

Figure 14b

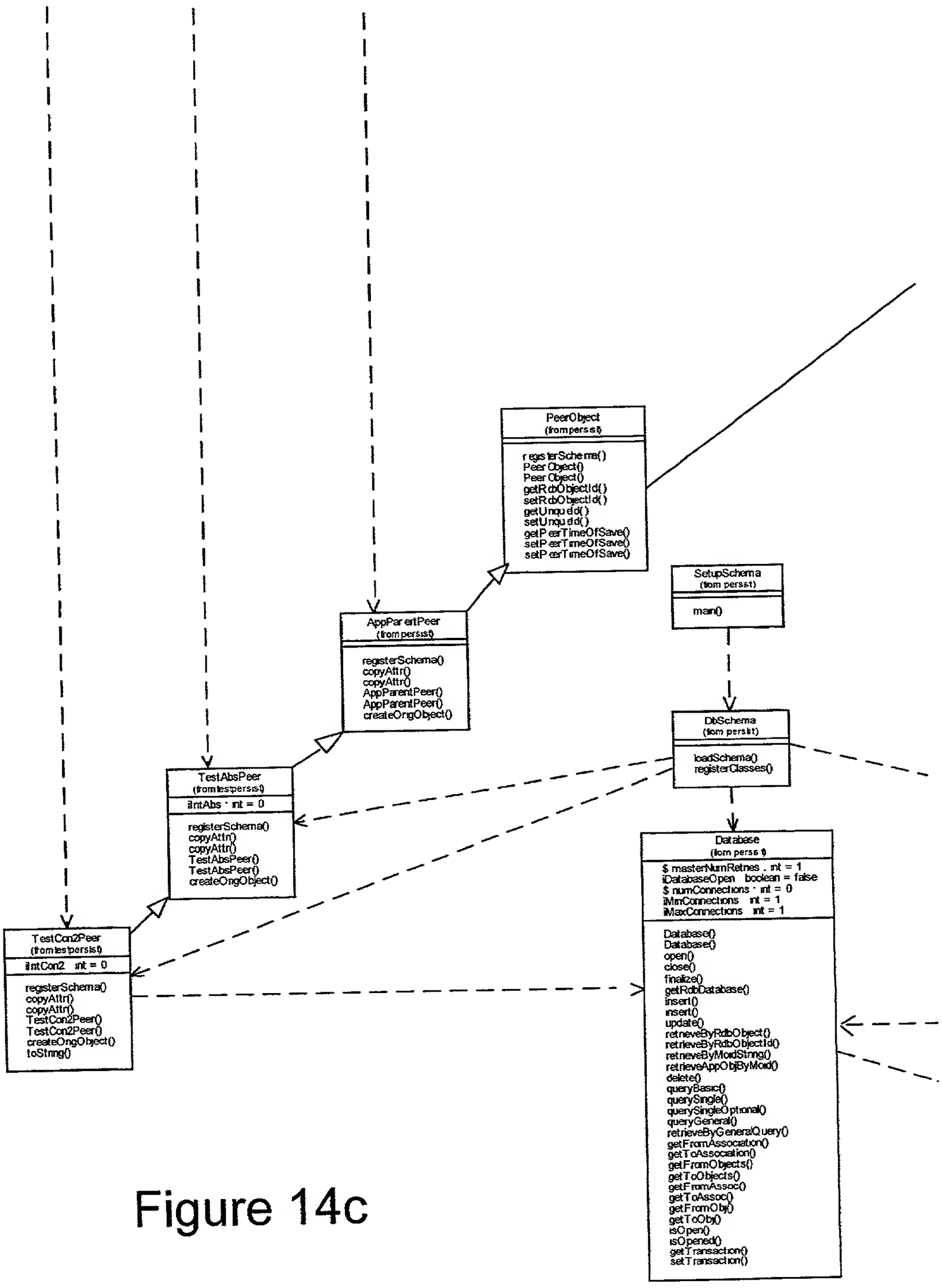

PeerObject
(from persist)
registerSchema()
PeerObject()
PeerObject()
getRdbObjectId()
setRdbObjectId()
getUnquId()
setUnquId()
getPeerTimeOfSave()
setPeerTimeOfSave()
setPeerTimeOfSave()
SetupSchema
(from persist)
main()
AppParentPeer
(from persist)
registerSchema()
copyAttr()
copyAttr()
AppParentPeer()
AppParentPeer()
createOrgObject()
DbSchema
(from persist)
loadSchema()
registerClasses()
TestAbsPeer
(from testpersist)
ilntAbs : int = 0
registerSchema()
copyAttr()
copyAttr()
TestAbsPeer()
TestAbsPeer()
createOrgObject()
Database
(from persist)
$ masterNumRetries : int = 1
iDatabaseOpen : boolean = false
$ numConnections : int = 0
iMinConnections : int = 1
iMaxConnections : int = 1
Database()
Database()
open()
close()
finalize()
getRdbDatabase()
insert()
insert()
update()
retreveByRdbObject()
retrieveByRdbObjectId()
retreveByMoidString()
retrieveAppObjByMoid()
delete()
queryBasic()
querySingle()
querySingleOptional()
queryGeneral()
retrieveByGeneralQuery()
getFromAssociation()
getToAssociation()
getFromObjects()
getToObjects()
getFromAssoc()
getToAssoc()
getFromObj()
getToObj()
isOpen()
isOpened()
getTransaction()
setTransaction()
TestCon2Peer
(from testpersist)
ilntCon2 : int = 0
registerSchema()
copyAttr()
copyAttr()
TestCon2Peer()
TestCon2Peer()
createOrgObject()
toString()

Figure 14c

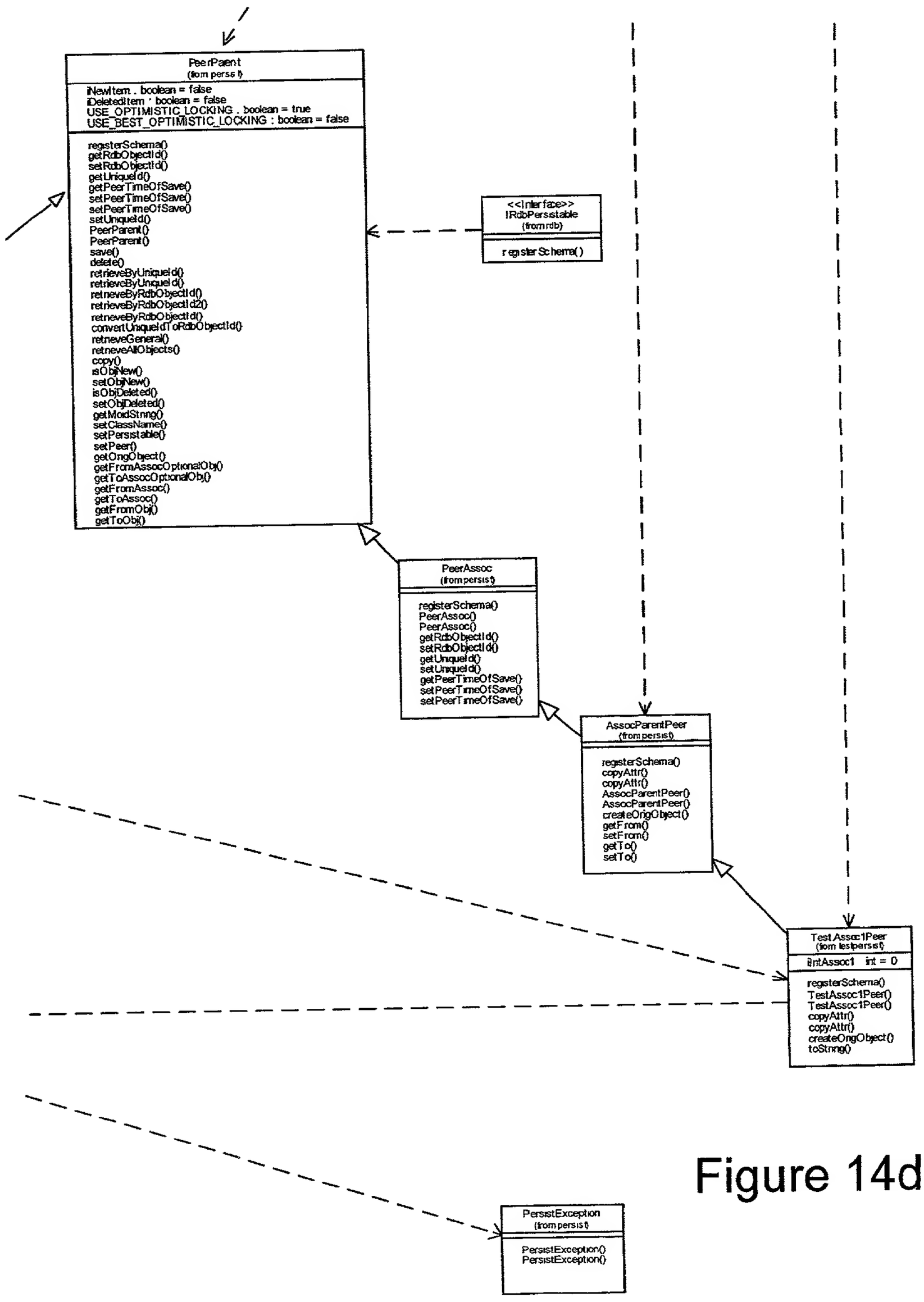
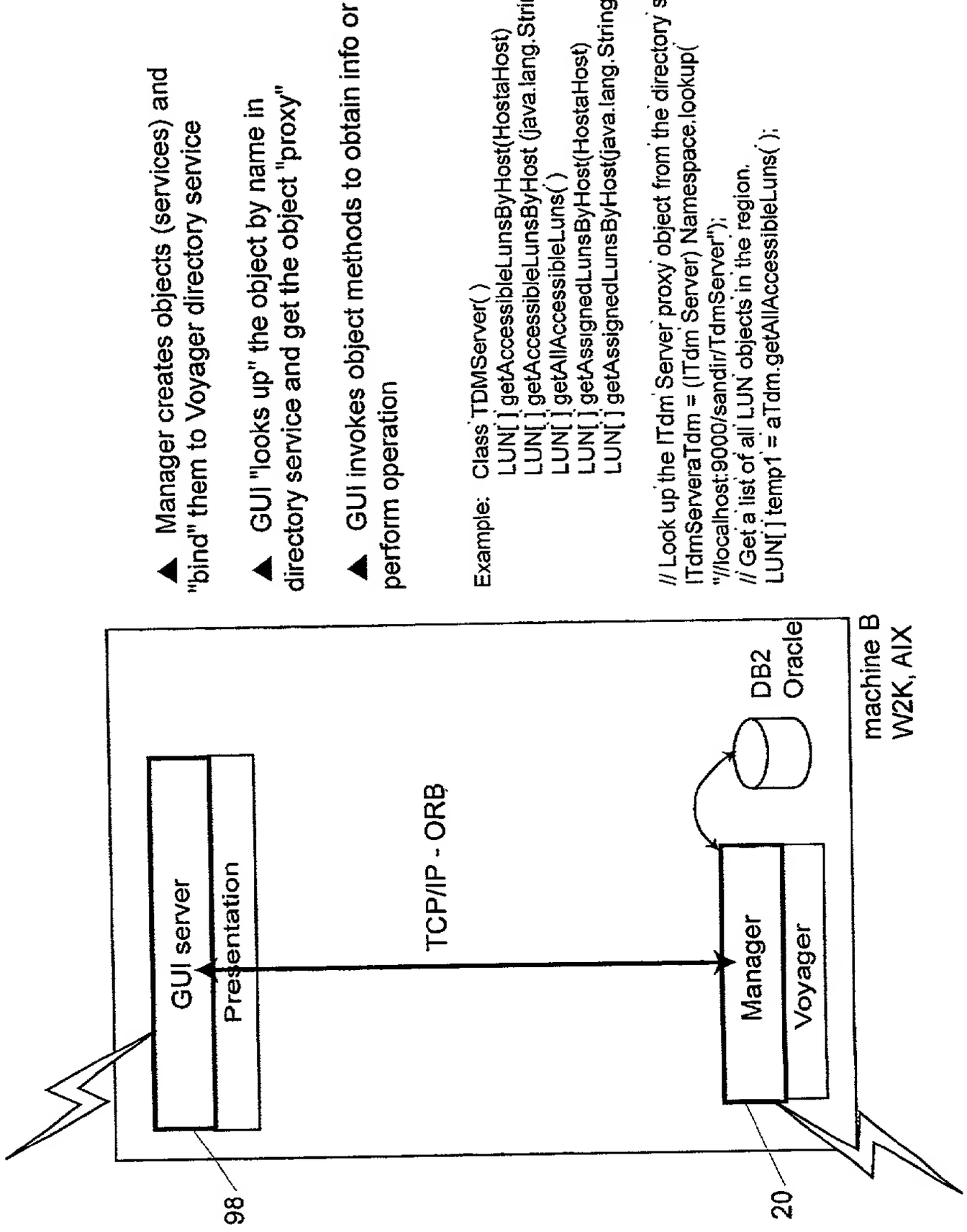

PeerParent
(from persist)
iNewItem : boolean = false
iDeletedItem : boolean = false
USE_OPTIMISTIC_LOCKING : boolean = true
USE_BEST_OPTIMISTIC_LOCKING : boolean = false
registerSchema()
getRdbObjectId()
setRdbObjectId()
getUniqueId()
getPeerTimeOfSave()
setPeerTimeOfSave()
setPeerTimeOfSave()
setUniqueId()
PeerParent()
PeerParent()
save()
delete()
retrieveByUniqueId()
retrieveByUniqueId()
retreveByRdbObjectId()
retrieveByRdbObjectId2()
retreveByRdbObjectId()
convertUniqueIdToRdbObjectId()
retreveGeneral()
retreveAllObjects()
copy()
isObjNew()
setObjNew()
isObjDeleted()
setObjDeleted()
getModString()
setClassName()
setPersistable()
setPeer()
getOrgObject()
getFromAssocOptionalObj()
getToAssocOptionalObj()
getFromAssoc()
getToAssoc()
getFromObj()
getToObj()
<<Interface>>
IRdbPersistable
(from rdb)
registerSchema()
PeerAssoc
(from persist)
registerSchema()
PeerAssoc()
PeerAssoc()
getRdbObjectId()
setRdbObjectId()
getUniqueId()
setUniqueId()
getPeerTimeOfSave()
setPeerTimeOfSave()
setPeerTimeOfSave()
AssocParentPeer
(from persist)
registerSchema()
copyAttr()
copyAttr()
AssocParentPeer()
AssocParentPeer()
createOrigObject()
getFrom()
setFrom()
getTo()
setTo()
TestAssoc1Peer
(from testpersist)
intAssoc1 : int = 0
registerSchema()
TestAssoc1Peer()
TestAssoc1Peer()
copyAttr()
copyAttr()
createOrigObject()
toString()
PersistException
(from persist)
PersistException()
PersistException()

Figure 14d

GUI (server) & Manager communication



▲ Manager creates objects (services) and "bind" them to Voyager directory service

▲ GUI "looks up" the object by name in directory service and get the object "proxy"

▲ GUI invokes object methods to obtain info or perform operation

```
Example:  Class TDMServer( )
              LUN[ ] getAccessibleLunsByHost(HostaHost)
              LUN[ ] getAccessibleLunsByHost (java.lang.String ip)
              LUN[ ] getAllAccessibleLuns( )
              LUN[ ] getAssignedLunsByHost(HostaHost)
              LUN[ ] getAssignedLunsByHost(java.lang.String ip)

// Look up the ITdm Server proxy object from the directory service
ITdmServeraTdm = (ITdm Server) Namespace.lookup(
"//localhost:9000/sandir/TdmServer");
// Get a list of all LUN objects in the region.
LUN[ ] temp1 = aTdm.getAllAccessibleLuns( );
```

Figure 15

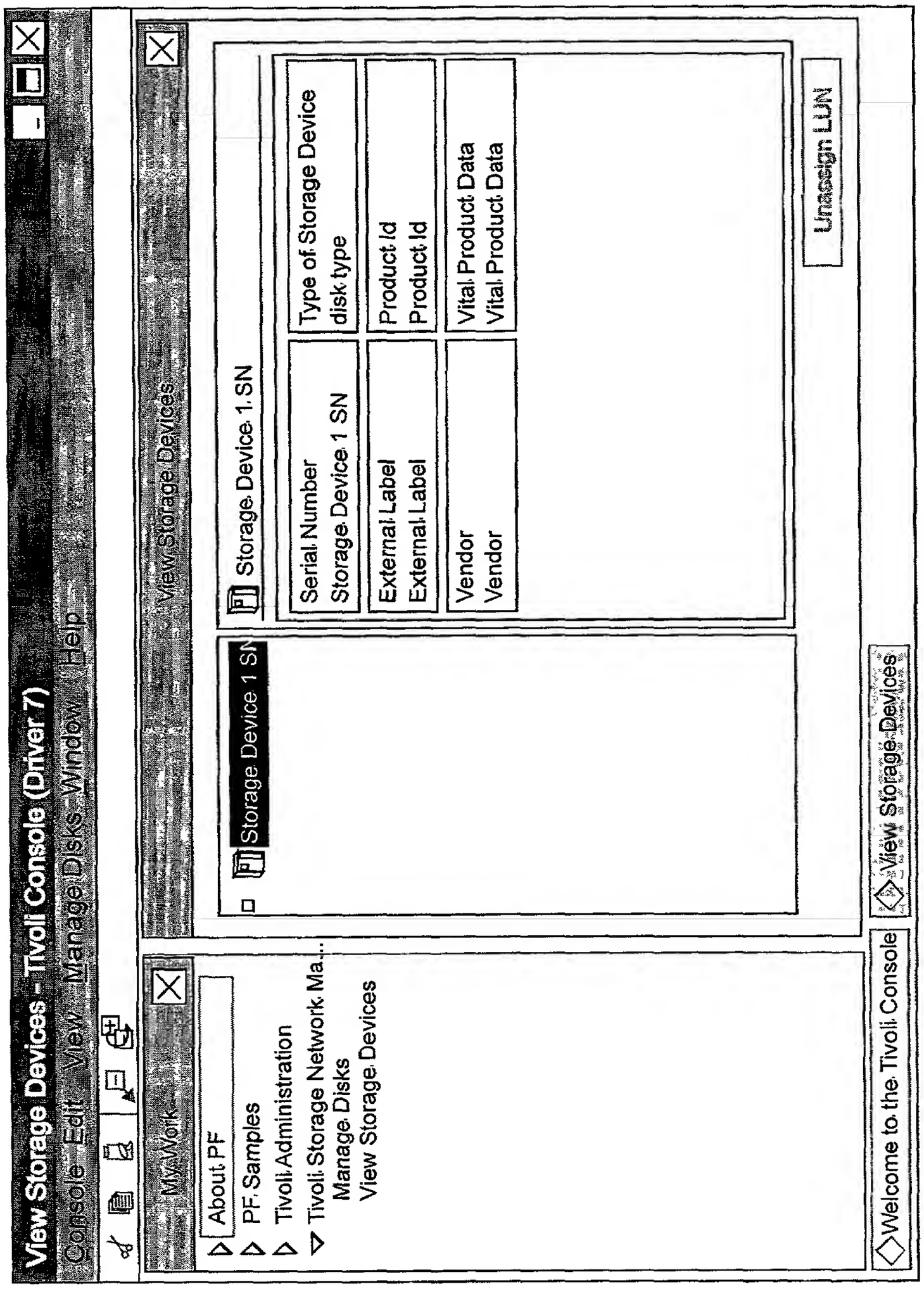

View Storage Devices - Tivoli Console (Driver 7)
Console Edit View Manage Disks Window Help
View Storage Devices
MyWork
About PF
PF Samples
Tivoli Administration
Tivoli Storage Network Ma...
Manage Disks
View Storage Devices
Storage Device 1 SN
Storage Device 1.SN
Serial Number
Storage Device 1 SN
External Label
External Label
Vendor
Vendor
Type of Storage Device
disk type
Product Id
Product Id
Vital Product Data
Vital Product Data
Unassign LUN
Welcome to the Tivoli Console
View Storage Devices
100

Figure 16

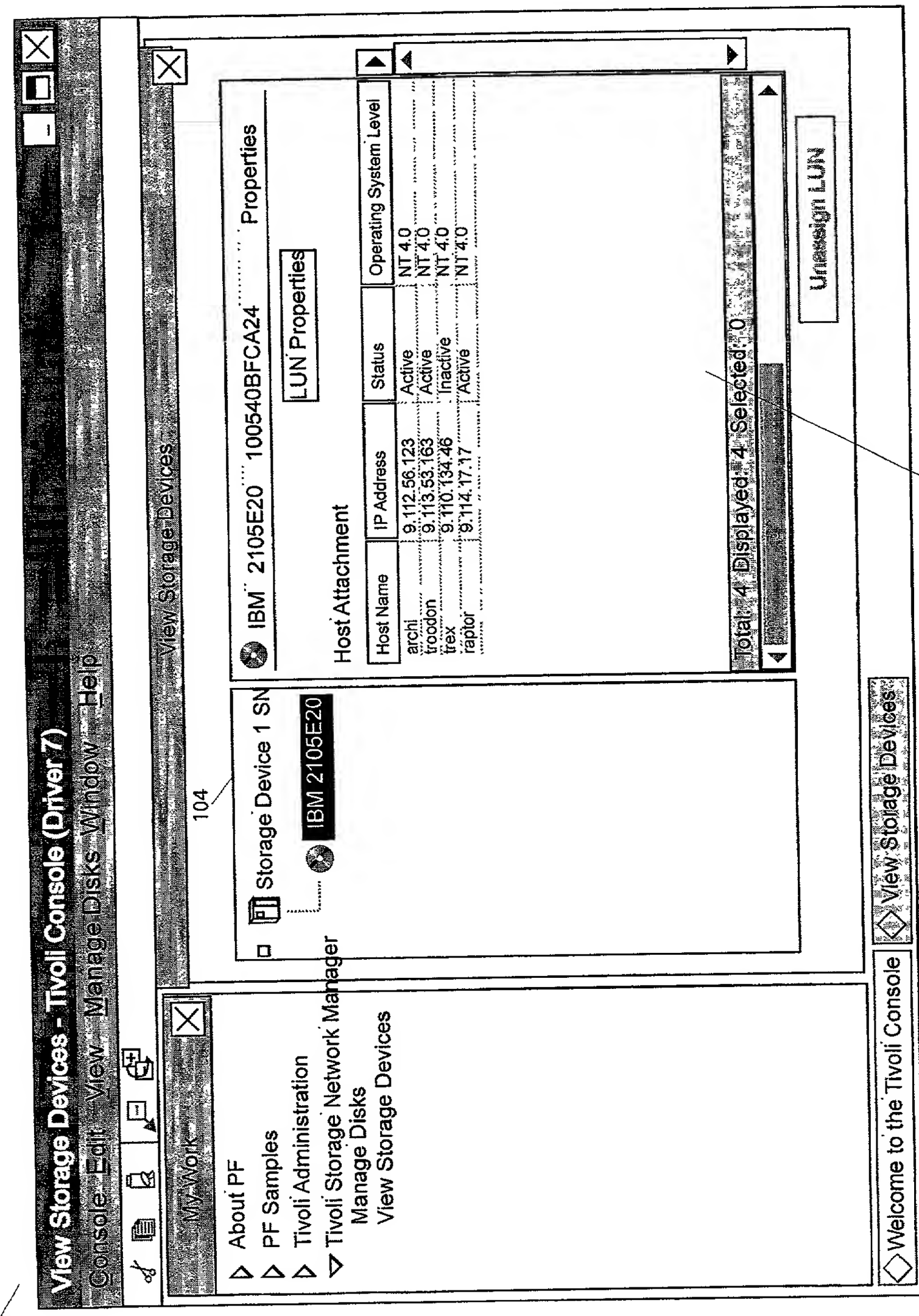

View Storage Devices - Tivoli Console (Driver 7)
Console Edit View Manage Disks Window Help
View Storage Devices
104
Storage Device 1 SN
IBM 2105E20
IBM 2105E20 100540BFCA24 Properties
LUN Properties
Host Attachment
Host Name
IP Address
Status
Operating System Level
archi 9.112.56.123 Active NT 4.0
troodon 9.113.53.163 Active NT 4.0
trex 9.110.134.46 Inactive NT 4.0
raptor 9.114.17.17 Active NT 4.0
Total: 4 Displayed: 4 Selected: 0
Unassign LUN
106
My Work
About PF
PF Samples
Tivoli Administration
Tivoli Storage Network Manager
Manage Disks
View Storage Devices
Welcome to the Tivoli Console
View Storage Devices
102

Figure 17

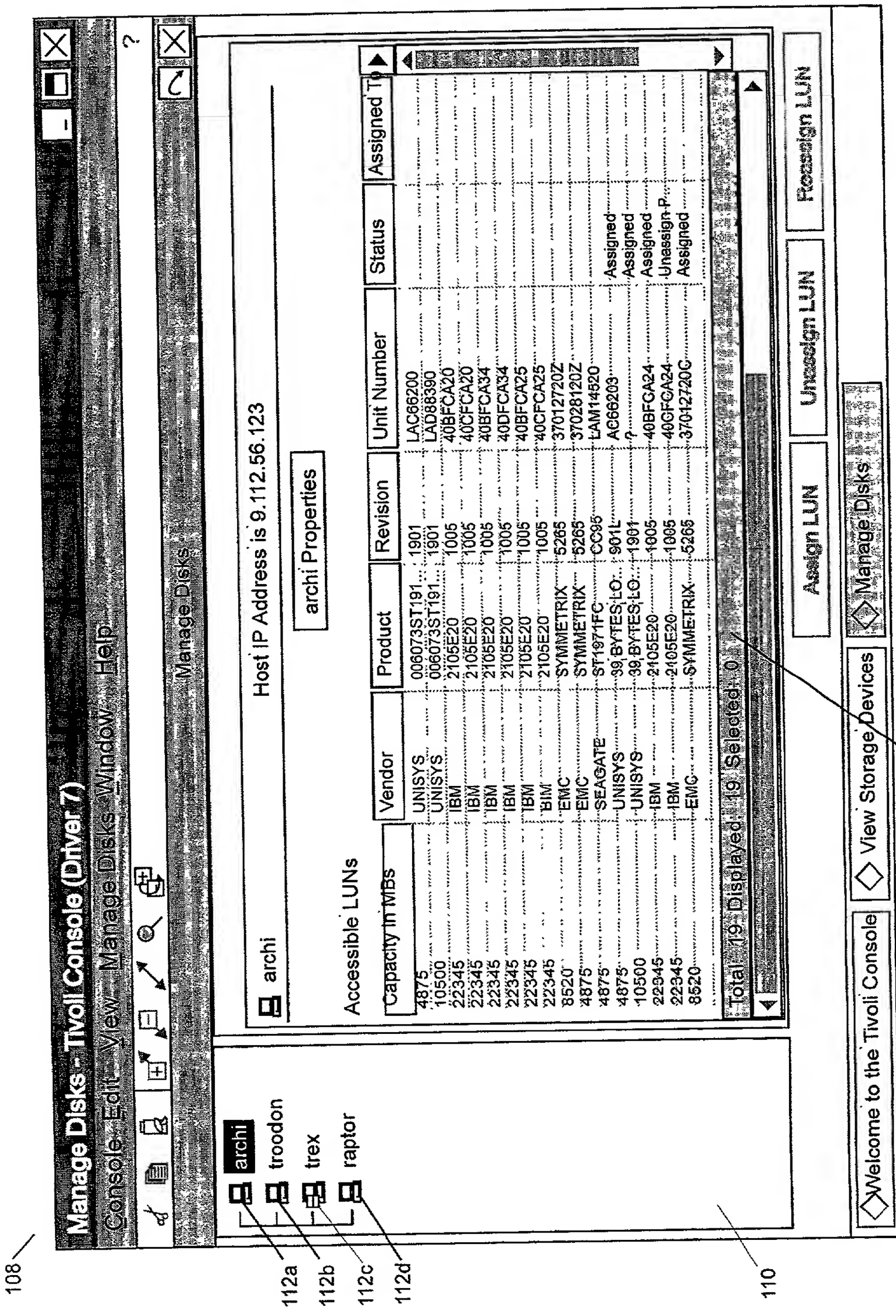

Manage Disks - Tivoli Console (Driver 7)
Console Edit View Manage Disks Window Help
Manage Disks
archi
Host IP Address is 9.112.56.123
archi Properties
Accessible LUNs
Capacity in MBs
Vendor
Product
Revision
Unit Number
Status
Assigned T
Total 19 Displayed, 19 Selected: 0
Assign LUN
Unassign LU
Reassign LUN
View Storage Devices
Manage Disks
Welcome to the Tivoli Console
troodon
trex
raptor
108
112a
112b
112c
112d
110
114

Figure 18

Result Checked

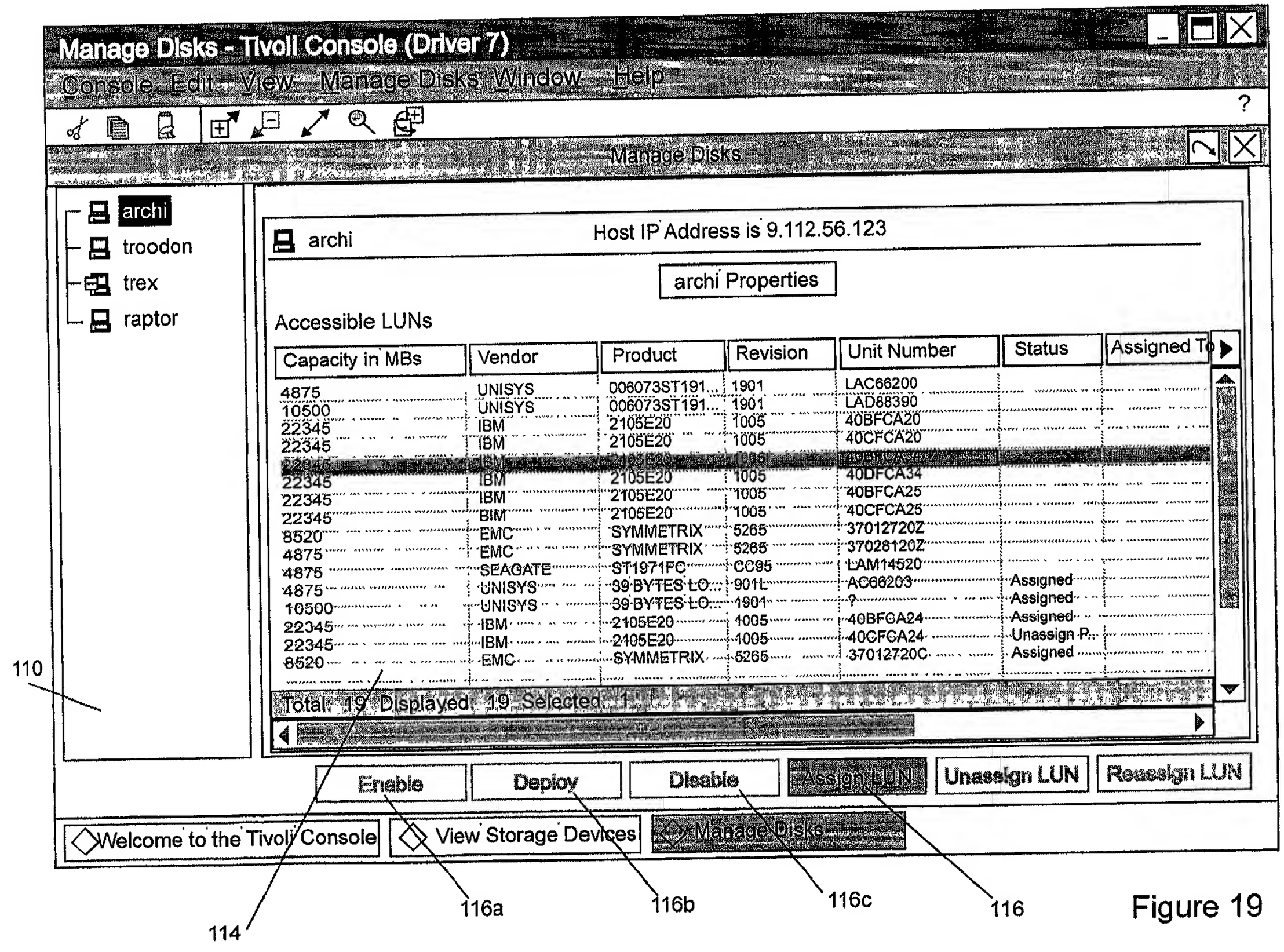


Figure 19

U.S. Express Mail Label No. EL 835 825 699 US

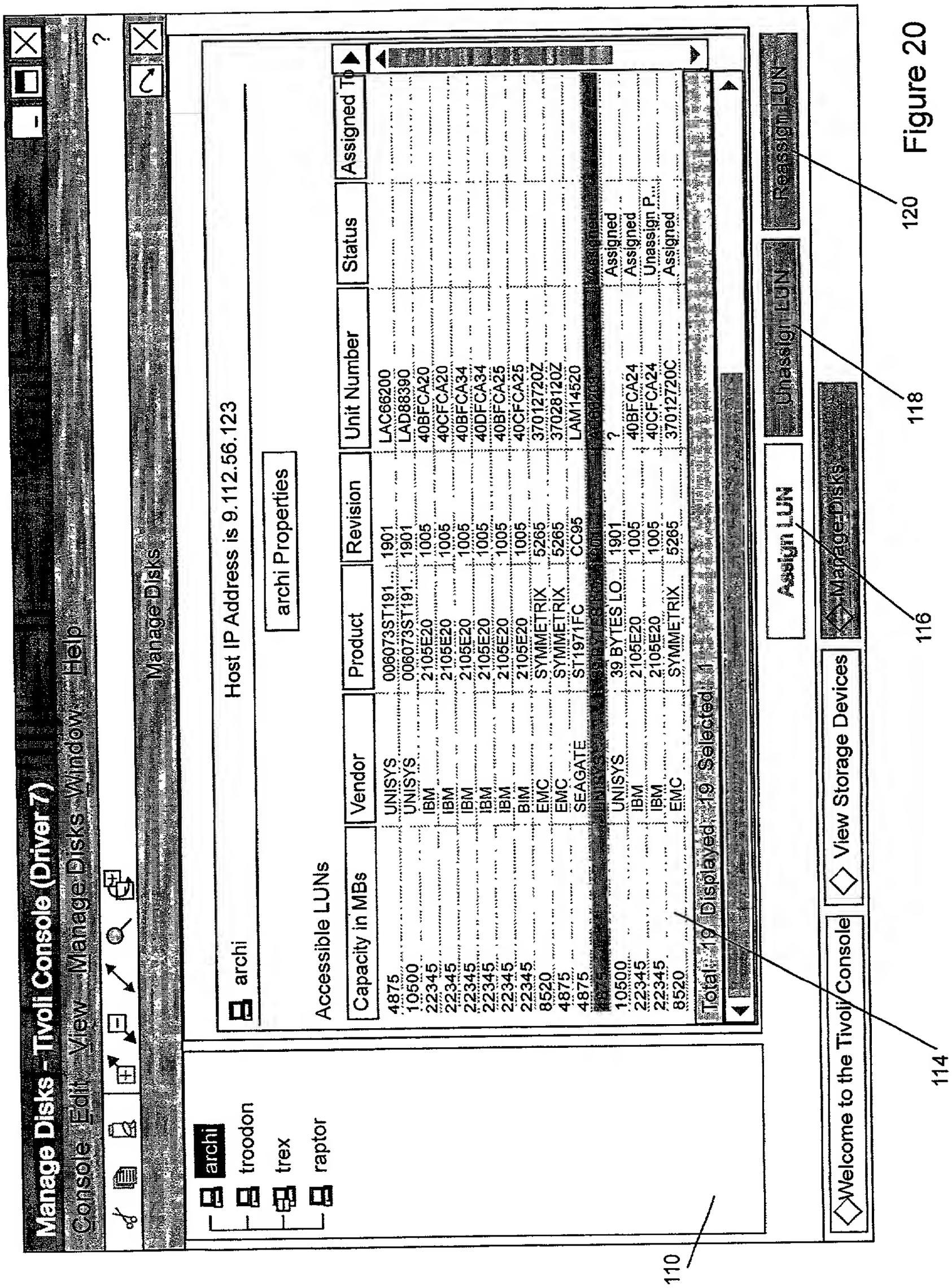

Manage Disks - Tivoli Console (Driver 7)
Console Edit View Manage Disks Window Help
Manage Disks
archi
troodon
trex
raptor
Host IP Address is 9.112.56.123
archi Properties
Accessible LUNs
Capacity in MBs
Vendor
Product
Revision
Unit Number
Status
Assigned To
Total: 19 Displayed: 19 Selected: 1
Assign LUN
Unassign LUN
Reassign LUN
Manage Disks
View Storage Devices
Welcome to the Tivoli Console
110
112
114
116
118
120

Figure 20

Clearing the Filter

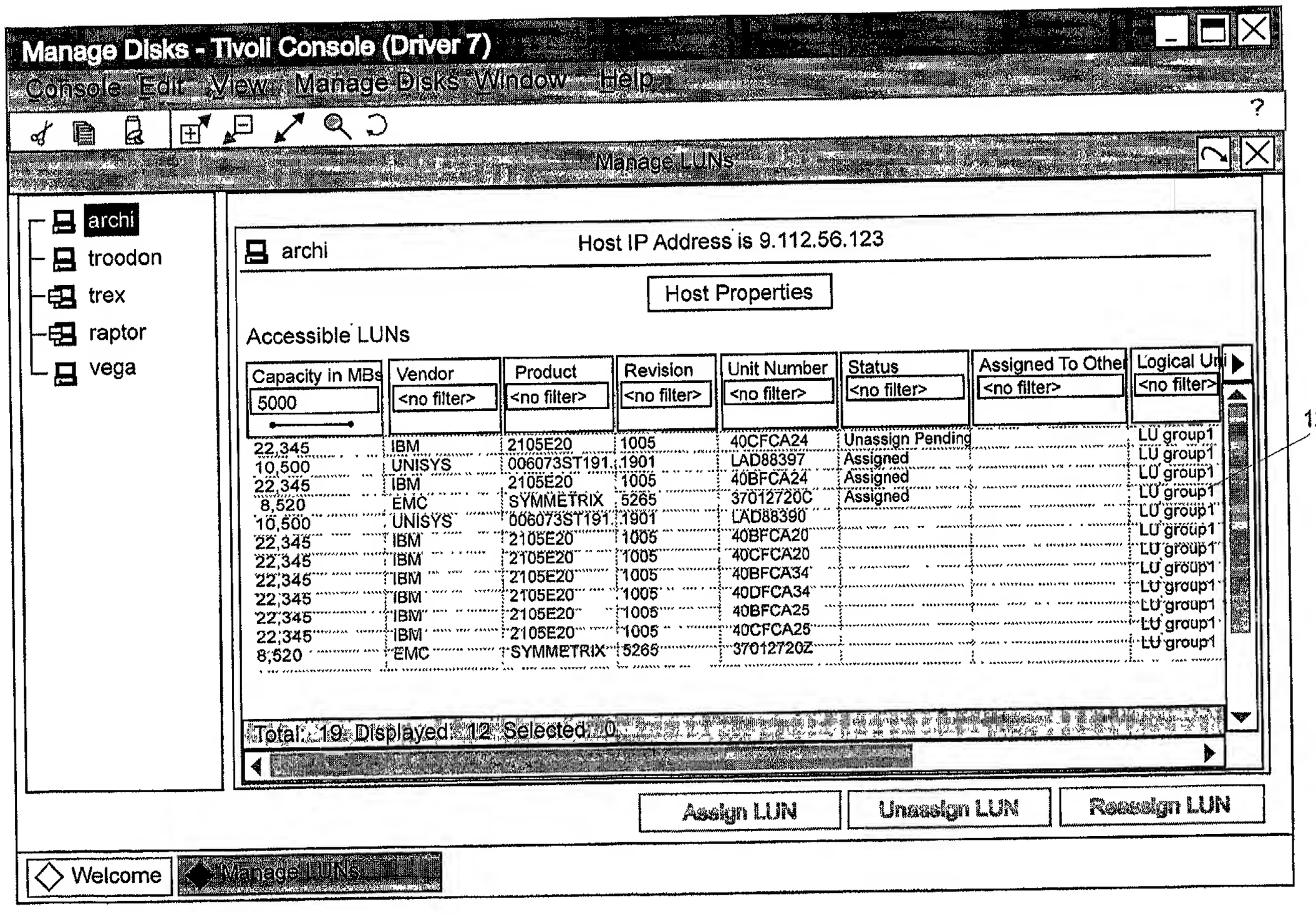


Figure 21

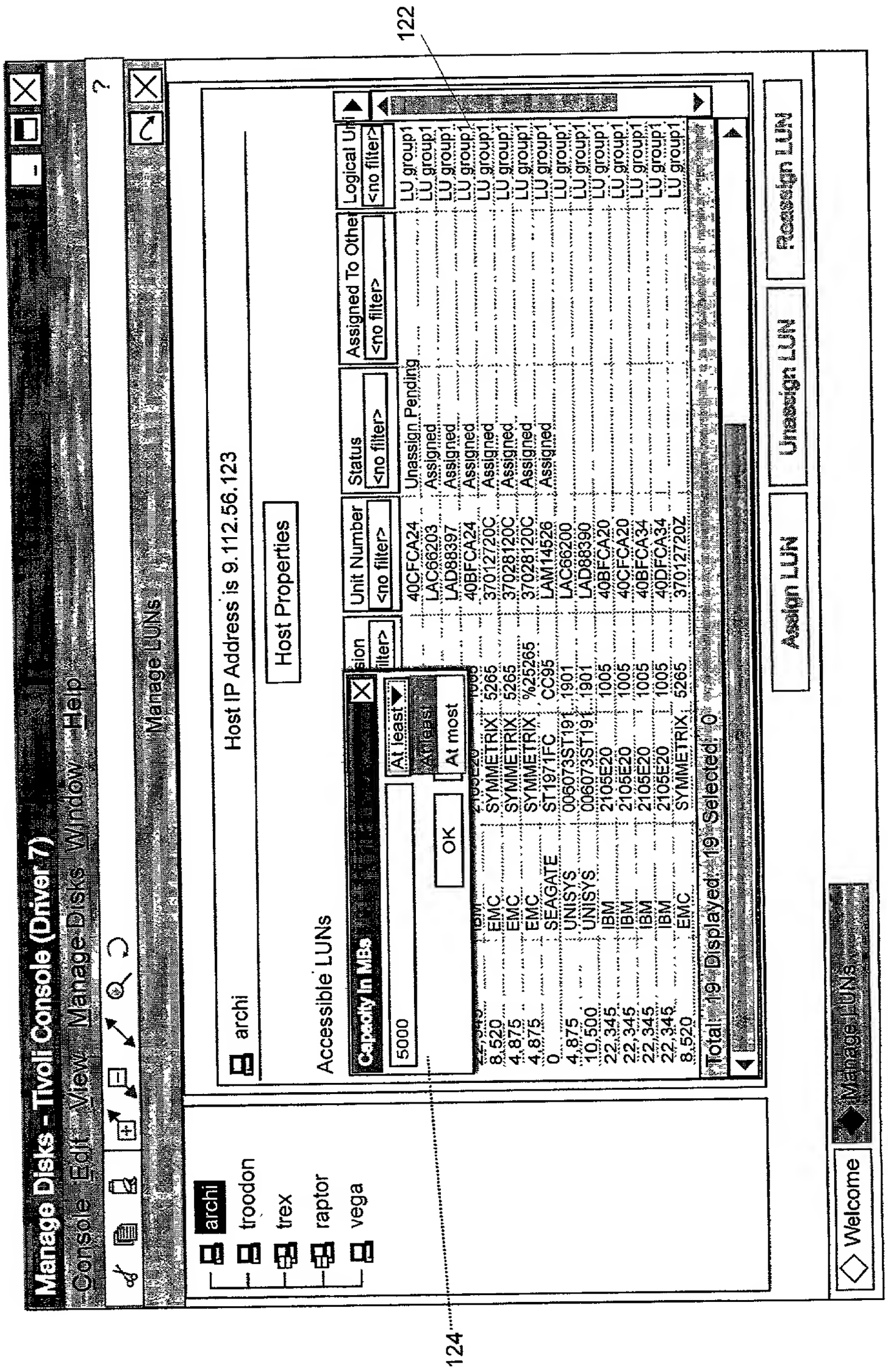

Custom Filtering
122
124
Manage Disks - Tivoli Console (Driver 7)
Console Edit View ManageDisks Window Help
Manage LUNs
Host IP Address is 9.112.56.123
archi
Host Properties
Accessible LUNs
Capacity in MBs
At least
At most
OK
Logical Unit
Assigned To Other
Unit Number
Status
Reassign LUN
Assign LUN
Unassign LUN
Total: 19 Displayed: 19 Selected: 0
archi
troodon
trex
raptor
vega
Welcome
Manage LUNs

Figure 22

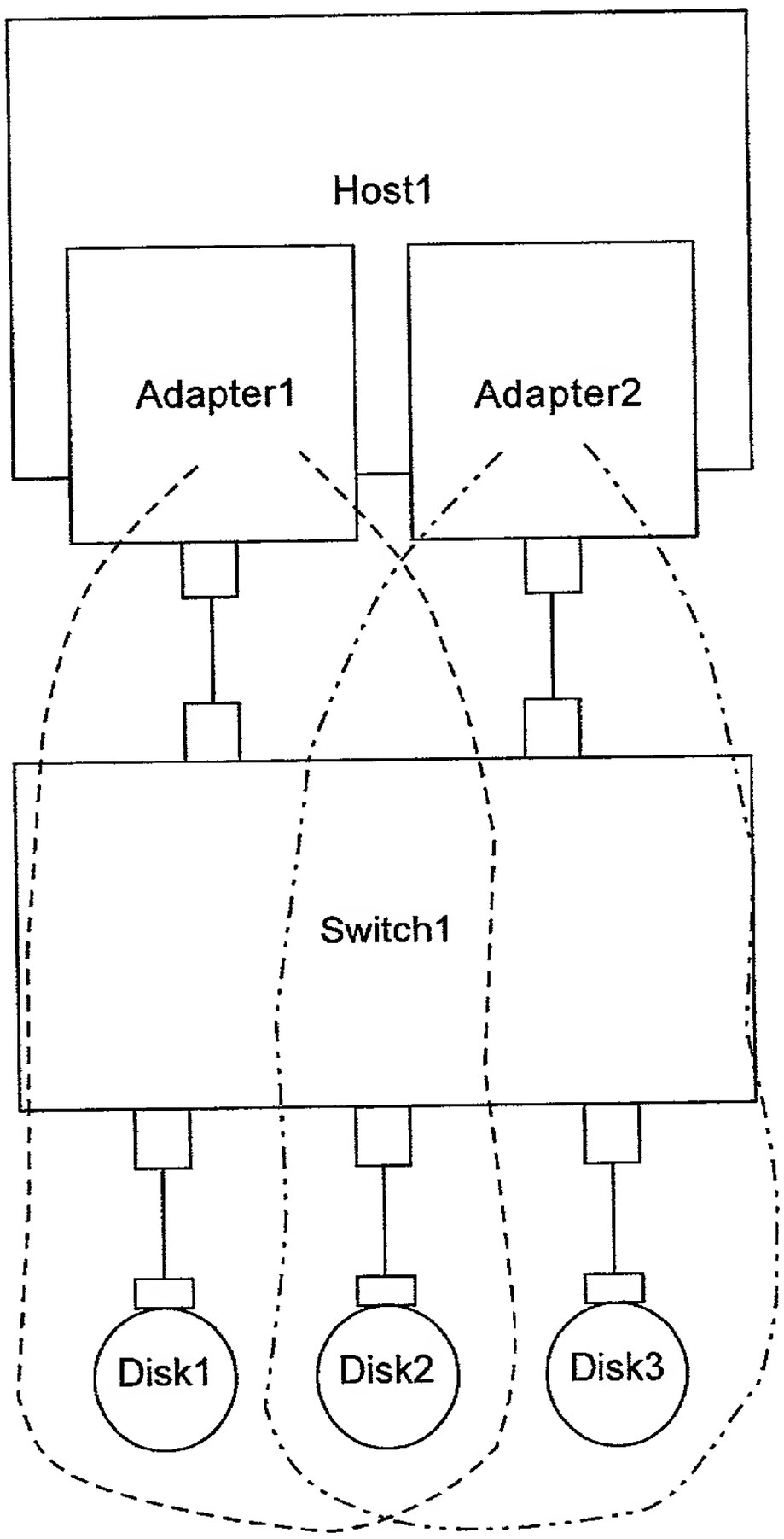


Figure 23

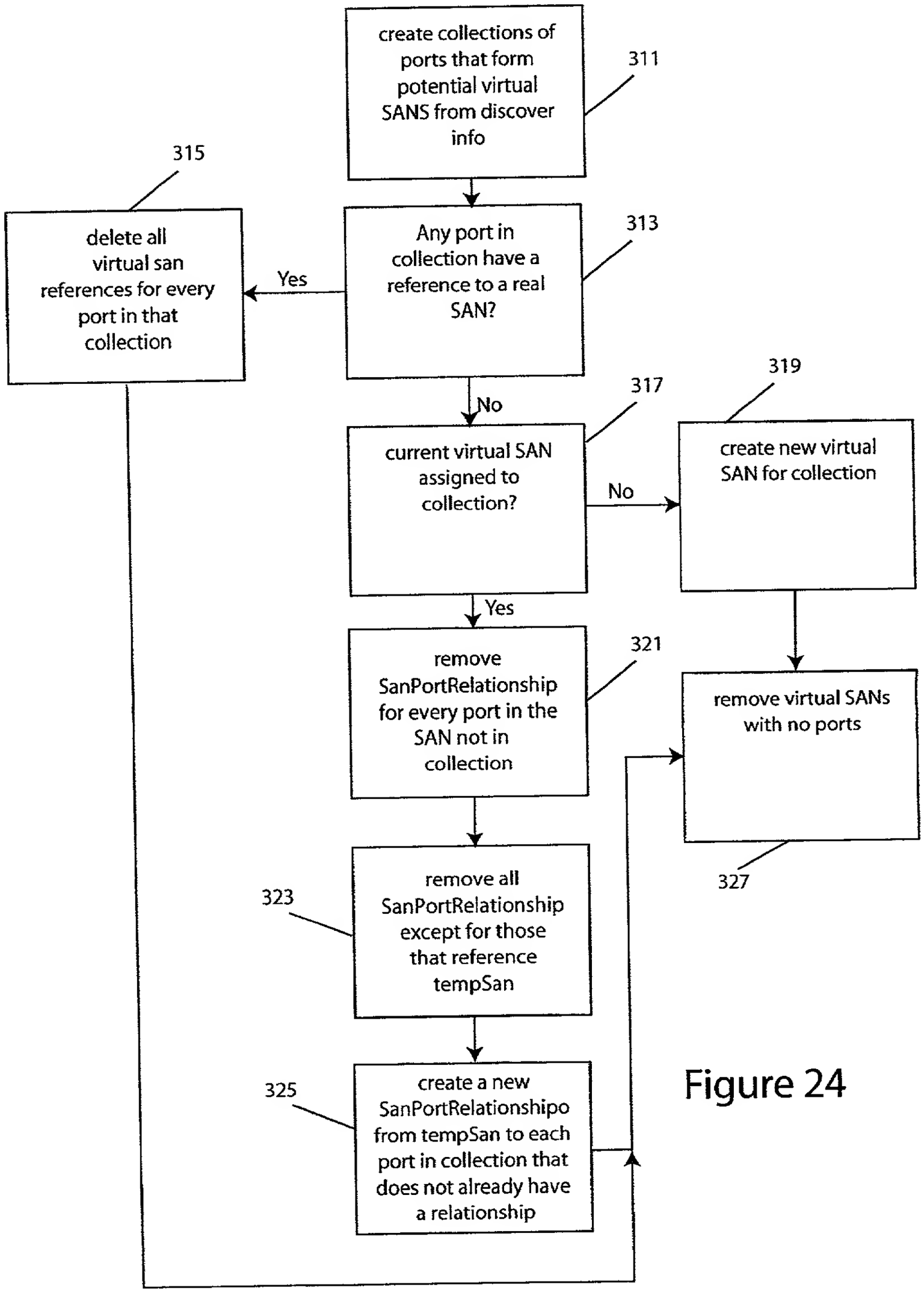

create collections of ports that form potential virtual SANS from discover info
311
Any port in collection have a reference to a real SAN?
313
Yes
delete all virtual san references for every port in that collection
315
No
current virtual SAN assigned to collection?
317
No
create new virtual SAN for collection
319
Yes
remove SanPortRelationship for every port in the SAN not in collection
321
remove all SanPortRelationship except for those that reference tempSan
323
create a new SanPortRelationshipo from tempSan to each port in collection that does not already have a relationship
325
remove virtual SANs with no ports
327

Figure 24

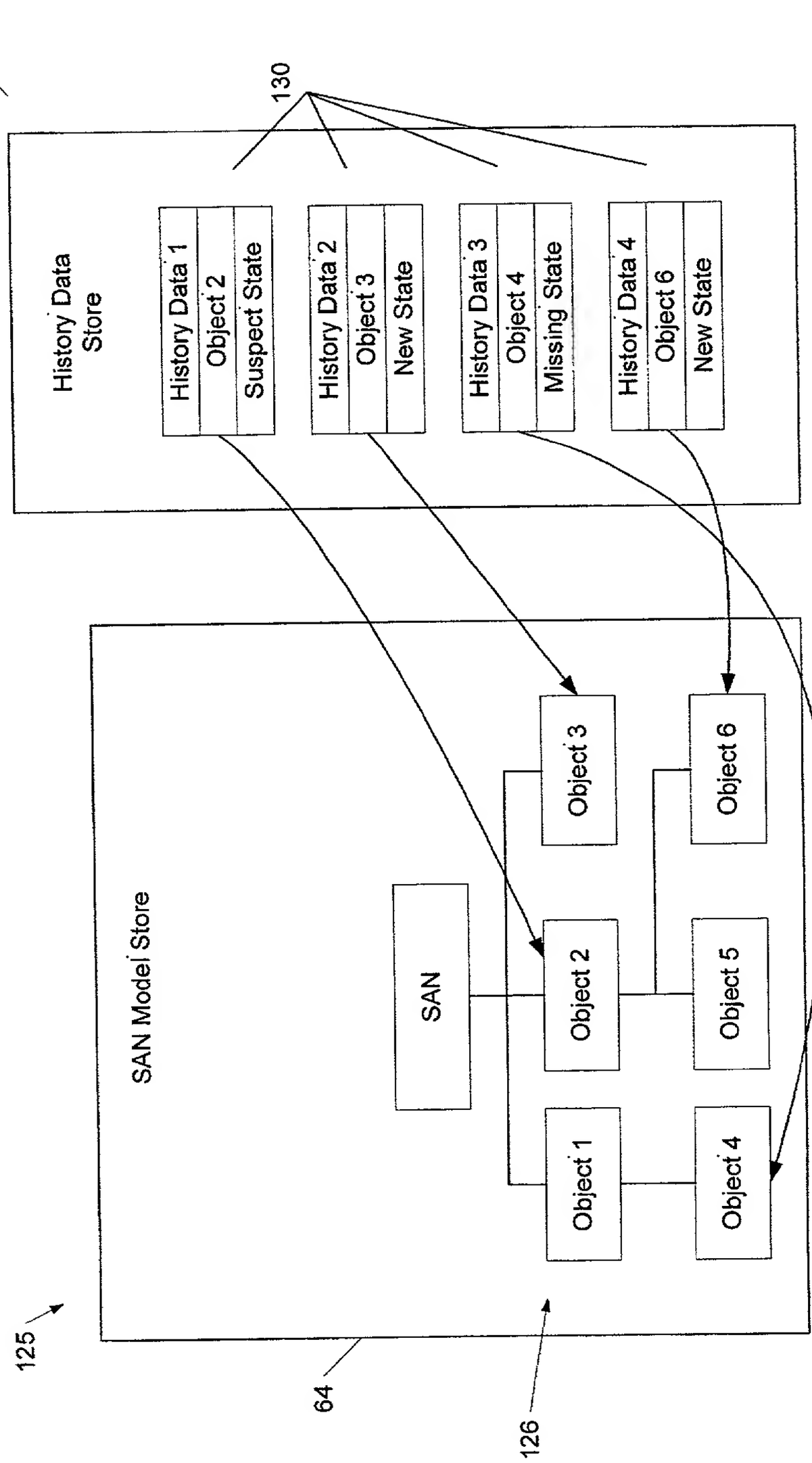

128
130
History Data Store
History Data 1
Object 2
Suspect State
History Data 2
Object 3
New State
History Data 3
Object 4
Missing State
History Data 4
Object 6
New State
SAN Model Store
SAN
Object 1
Object 2
Object 3
Object 4
Object 5
Object 6
125
64
126

FIGURE 25

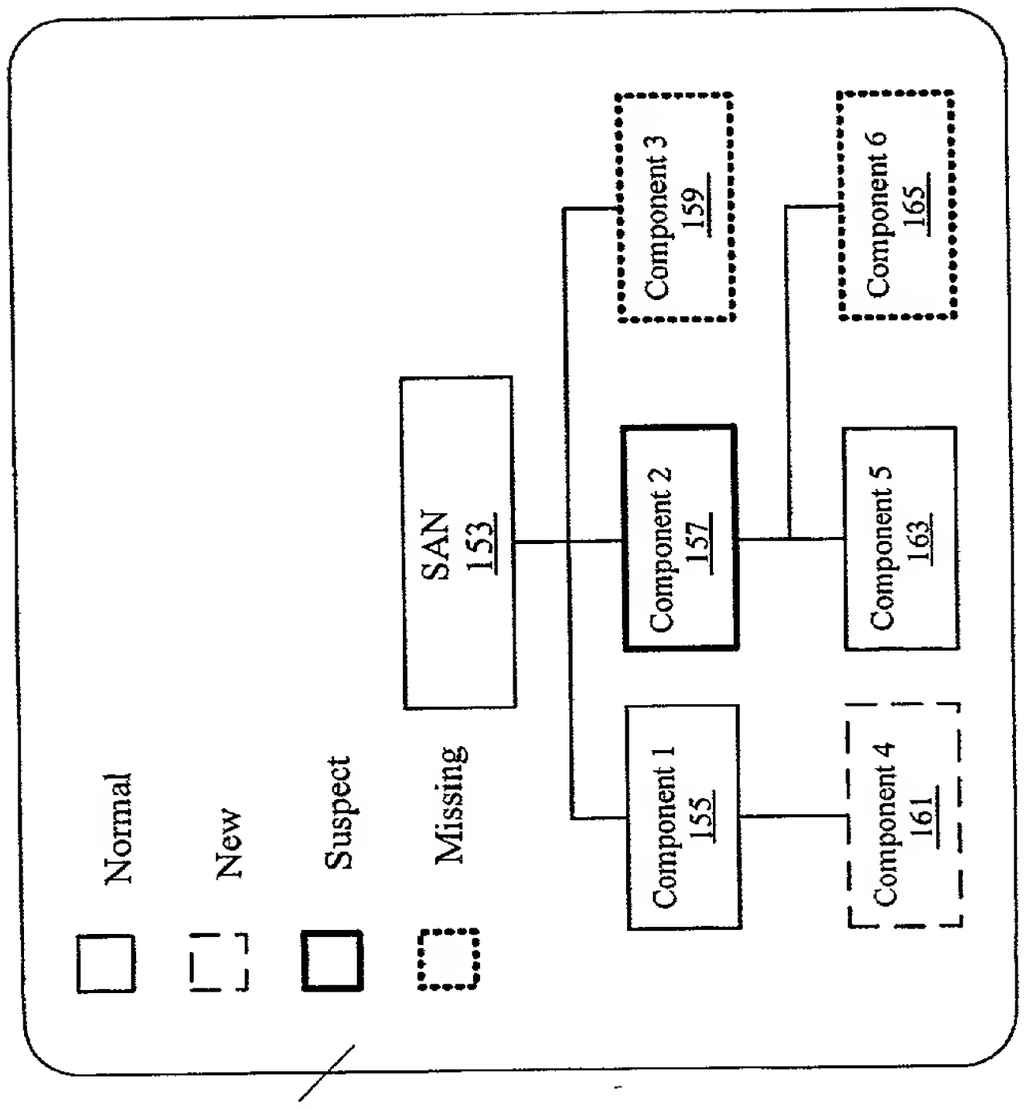

151
Normal
New
Suspect
Missing
SAN
153
Component 1
155
Component 2
157
Component 3
159
Component 4
161
Component 5
163
Component 6
165

FIGURE 26

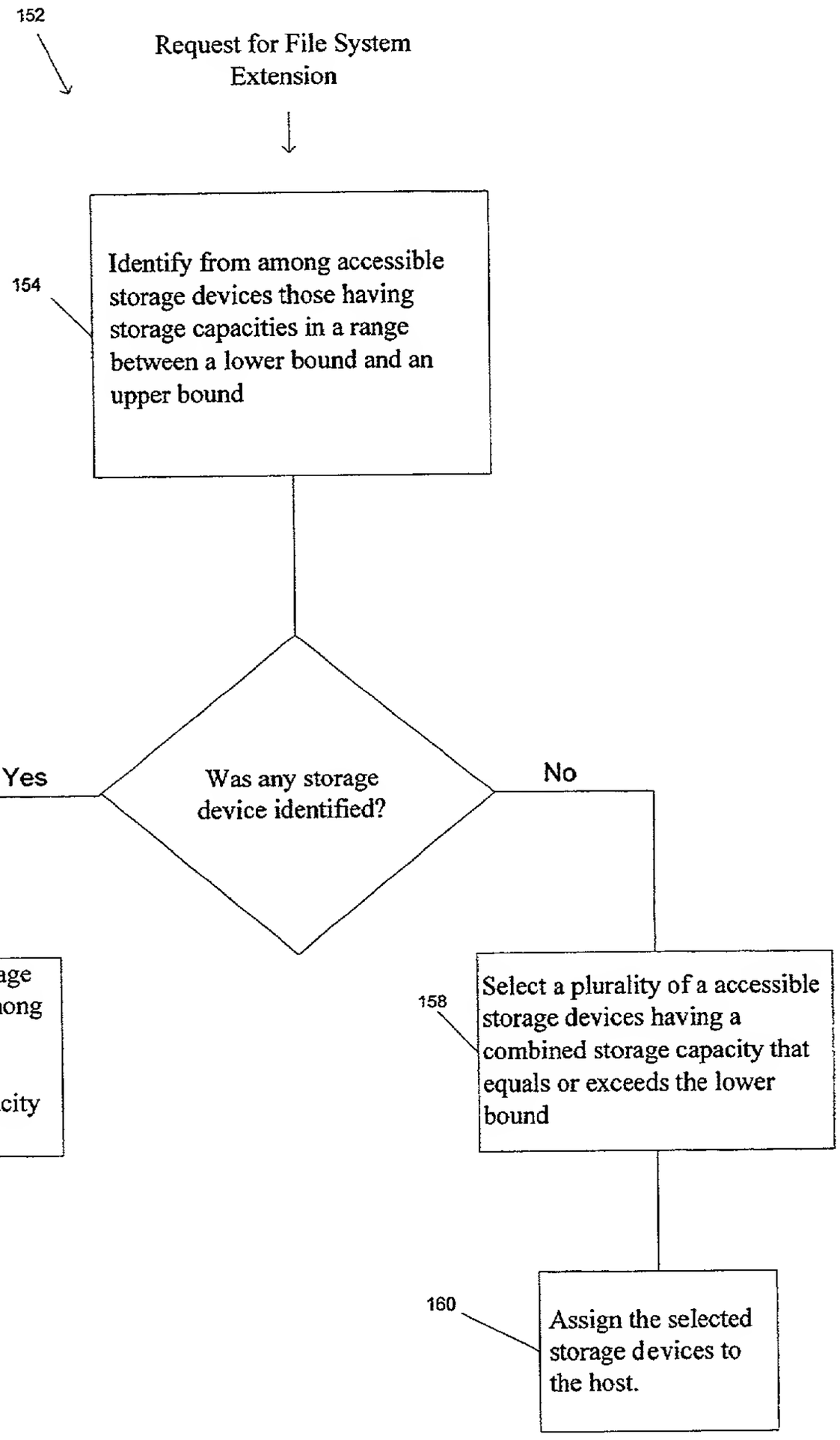

152
Request for File System Extension
154
Identify from among accessible storage devices those having storage capacities in a range between a lower bound and an upper bound
Was any storage device identified?
Yes
No
156
Assign the storage device from among the identified devices with maximum capacity to the host
158
Select a plurality of a accessible storage devices having a combined storage capacity that equals or exceeds the lower bound
160
Assign the selected storage devices to the host.

Figure 27

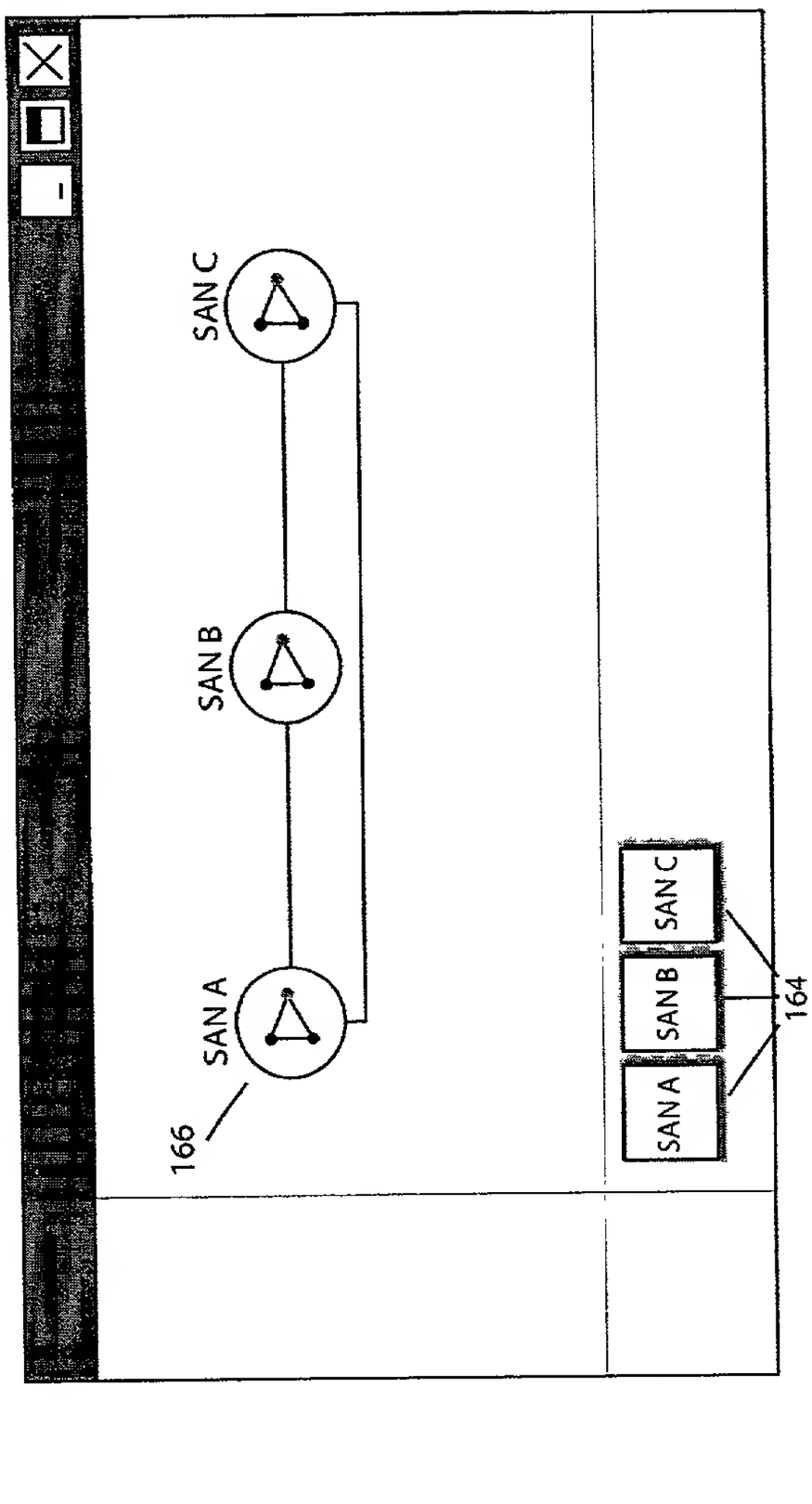


Figure 28

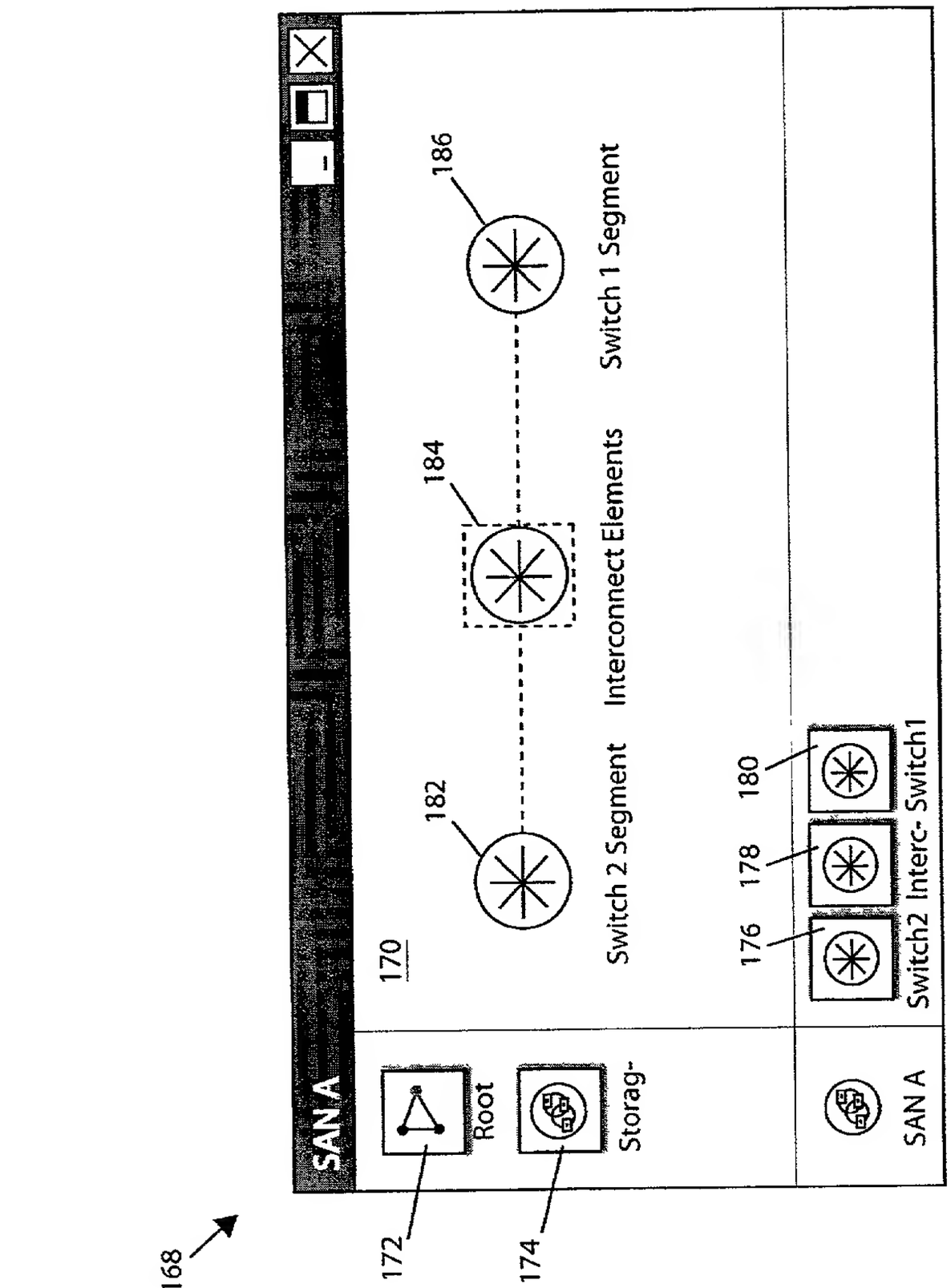

168
SAN A
170
172
Root
174
Storag-
182
Switch 2 Segment
184
Interconnect Elements
186
Switch 1 Segment
176
178
180
SAN A
Switch2 Interc- Switch1

Figure 29

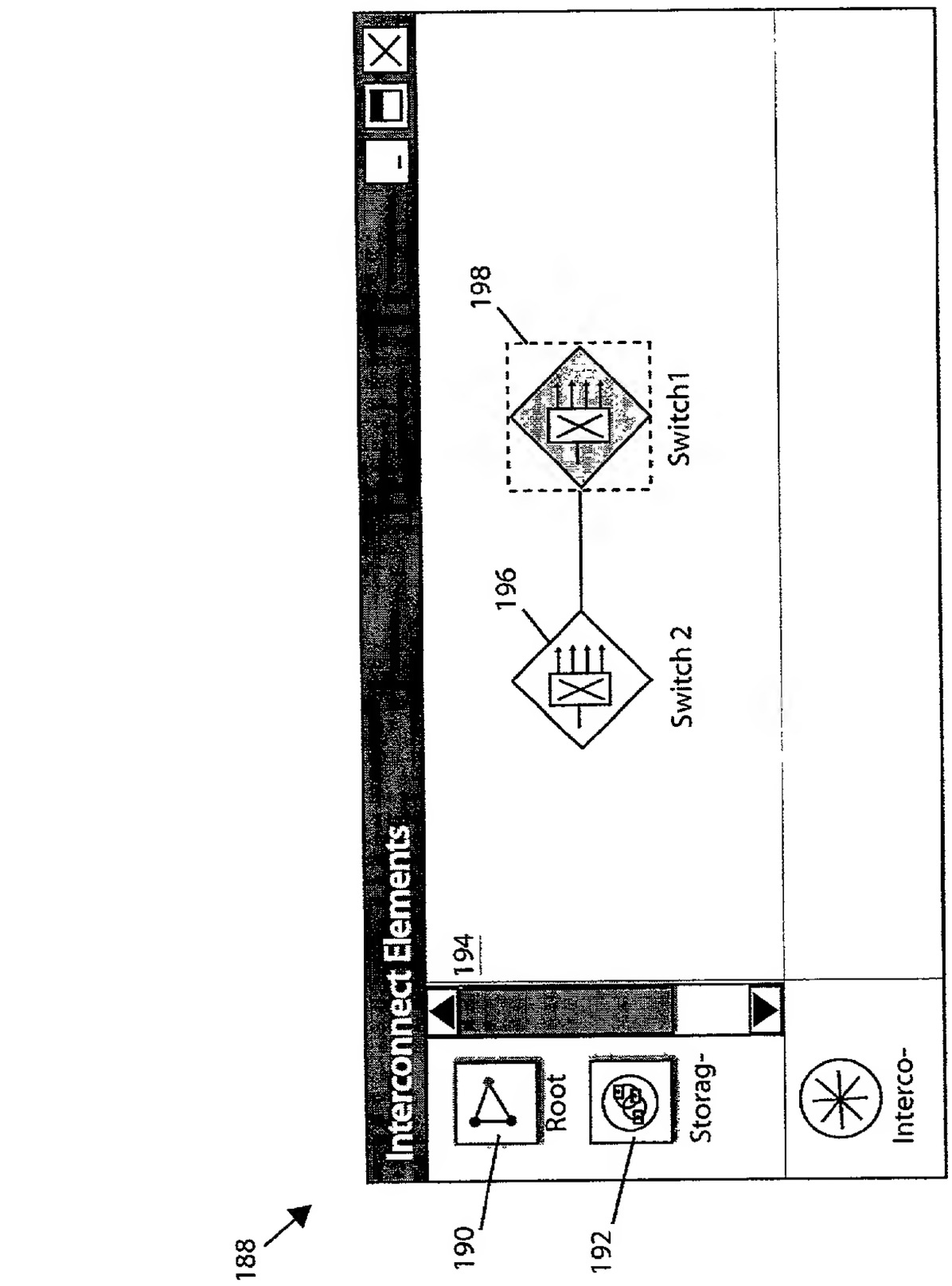

188
Interconnect Elements
194
190
Root
192
Storag-
Interco-
196
Switch 2
198
Switch1

Figure 30

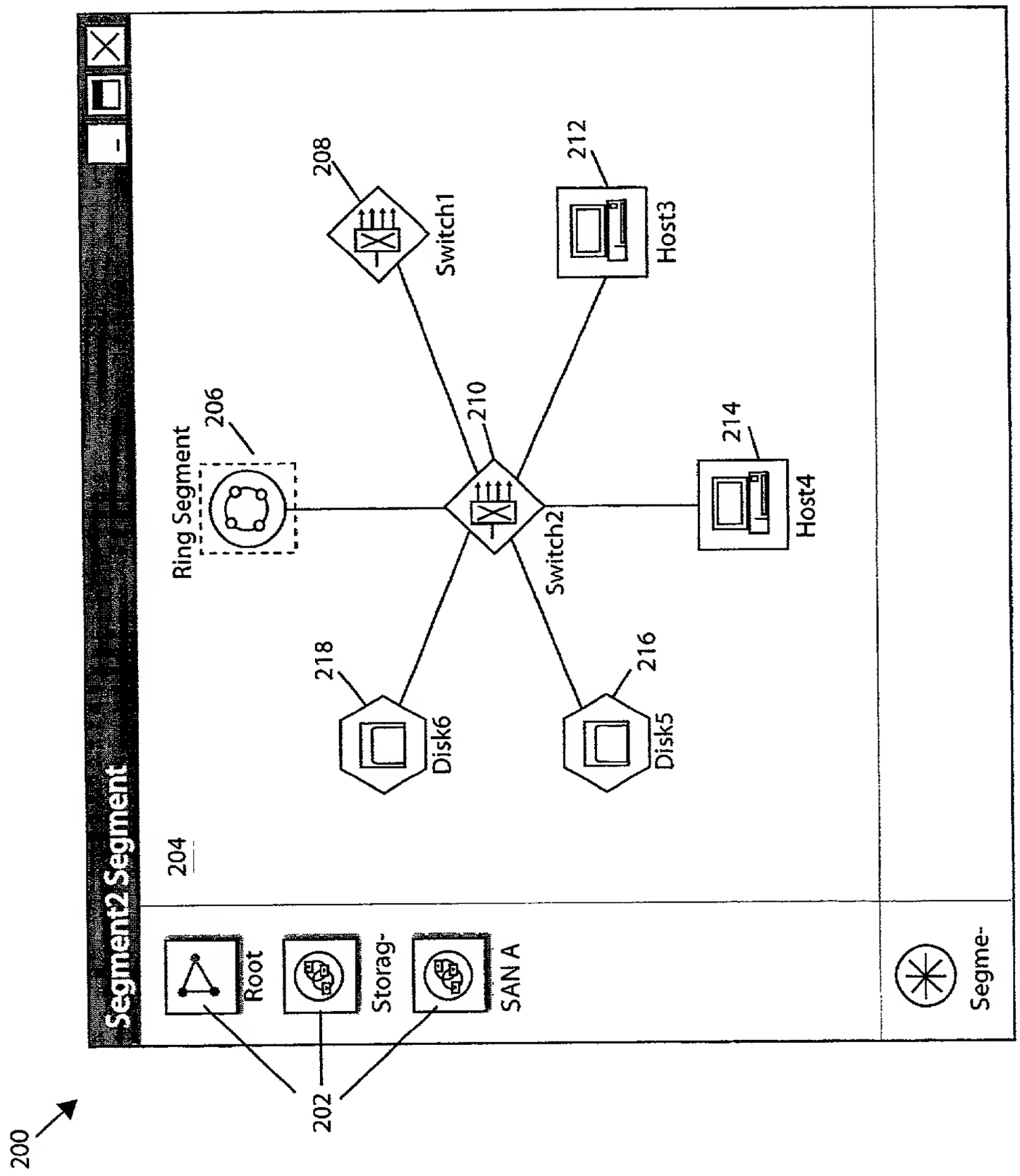

200
202
Segment2 Segment
204
Root
Storag-
SAN A
Segme-
Ring Segment
206
208
Switch1
210
Switch2
212
Host3
214
Host4
216
Disk5
218
Disk6

Figure 31

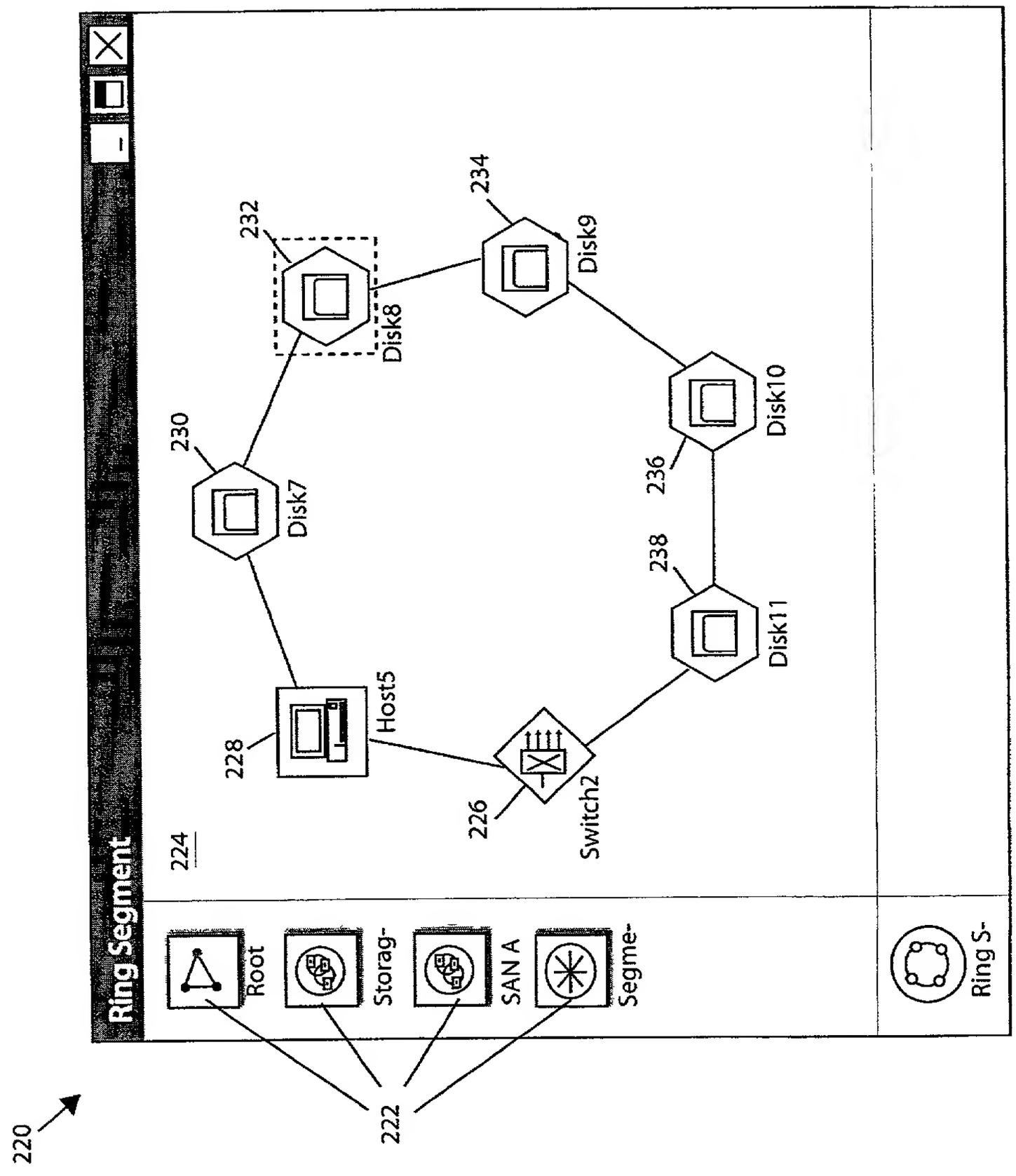
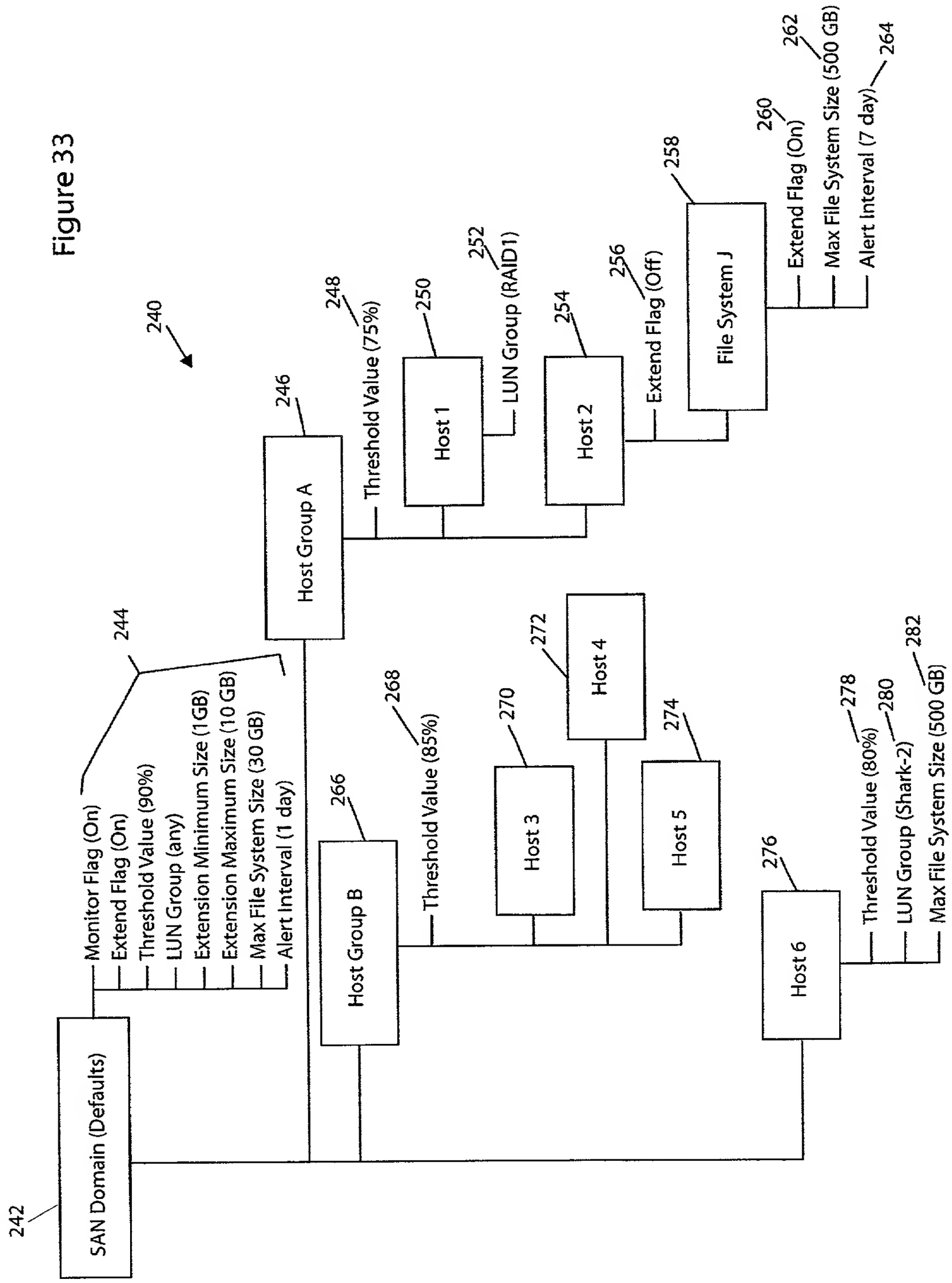

Ring Segment
224
Root
Storag-
SAN A
Segme-
Ring S-
228
Host5
230
Disk7
232
Disk8
234
Disk9
Disk10
236
238
Disk11
226
Switch2
220
222

Figure 32

Figure 33


240
SAN Domain (Defaults)
242
Monitor Flag (On)
Extend Flag (On)
Threshold Value (90%)
LUN Group (any)
Extension Minimum Size (1GB)
Extension Maximum Size (10 GB)
Max File System Size (30 GB)
Alert Interval (1 day)
244
Host Group A
246
Threshold Value (75%)
248
Host 1
LUN Group
250
Host 2
252
Extend Flag
Group (RAID1)
254
File System J
256
Extend Flag (Off)
258
Extend Flag (On)
260
Max File System Size (500 GB)
262
Alert Interval (7 day)
264
Host Group B
266
Threshold Value (85%)
268
Host 3
270
Host 4
272
Host 5
274
Host 6
276
Threshold Value (80%)
278
LUN Group (Shark-2)
280
Max File System Size (500 GB)
282

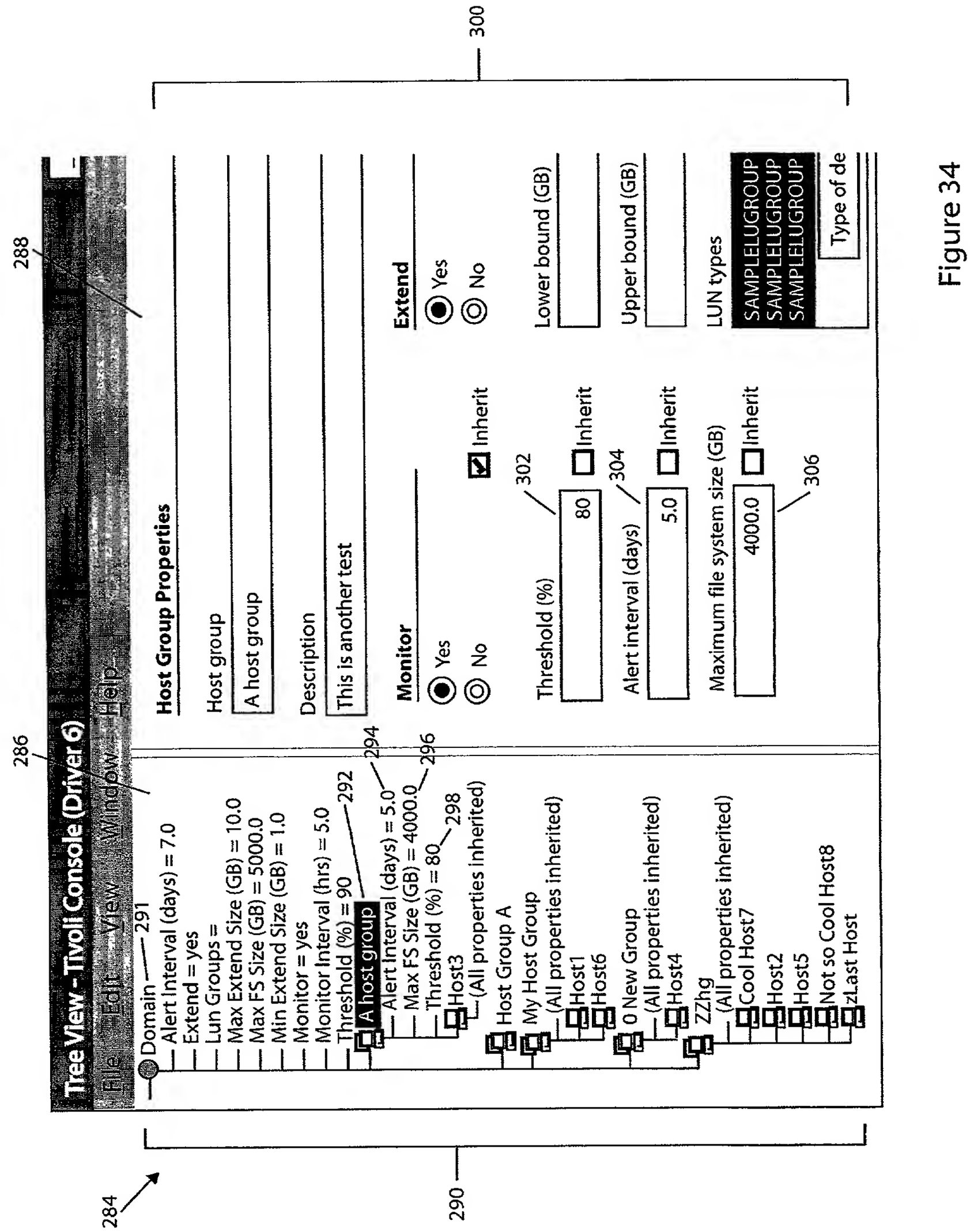

Tree View - Tivoli Console (Driver 6)
File Edit View Window Help
Domain
Alert Interval (days) = 7.0
Extend = yes
Lun Groups =
Max Extend Size (GB) = 10.0
Max FS Size (GB) = 5000.0
Min Extend Size (GB) = 1.0
Monitor = yes
Monitor Interval (hrs) = 5.0
Threshold (%) = 90
A host group
Alert Interval (days) = 5.0
Max FS Size (GB) = 4000.0
Threshold (%) = 80
Host3
(All properties inherited)
Host Group A
My Host Group
(All properties inherited)
Host1
Host6
0 New Group
(All properties inherited)
Host4
ZZhg
(All properties inherited)
Cool Host7
Host2
Host5
Not so Cool Host8
zLast Host
Host Group Properties
Host group
A host group
Description
This is another test
Monitor
Yes
No
Inherit
Threshold (%)
80
Inherit
Alert interval (days)
5.0
Inherit
Maximum file system size (GB)
4000.0
Inherit
Extend
Yes
No
Lower bound (GB)
Upper bound (GB)
LUN types
SAMPLELUGROUP
SAMPLELUGROUP
SAMPLELUGROUP
Type of de
284
286
288
290
291
292
294
296
298
300
302
304
306

Figure 34

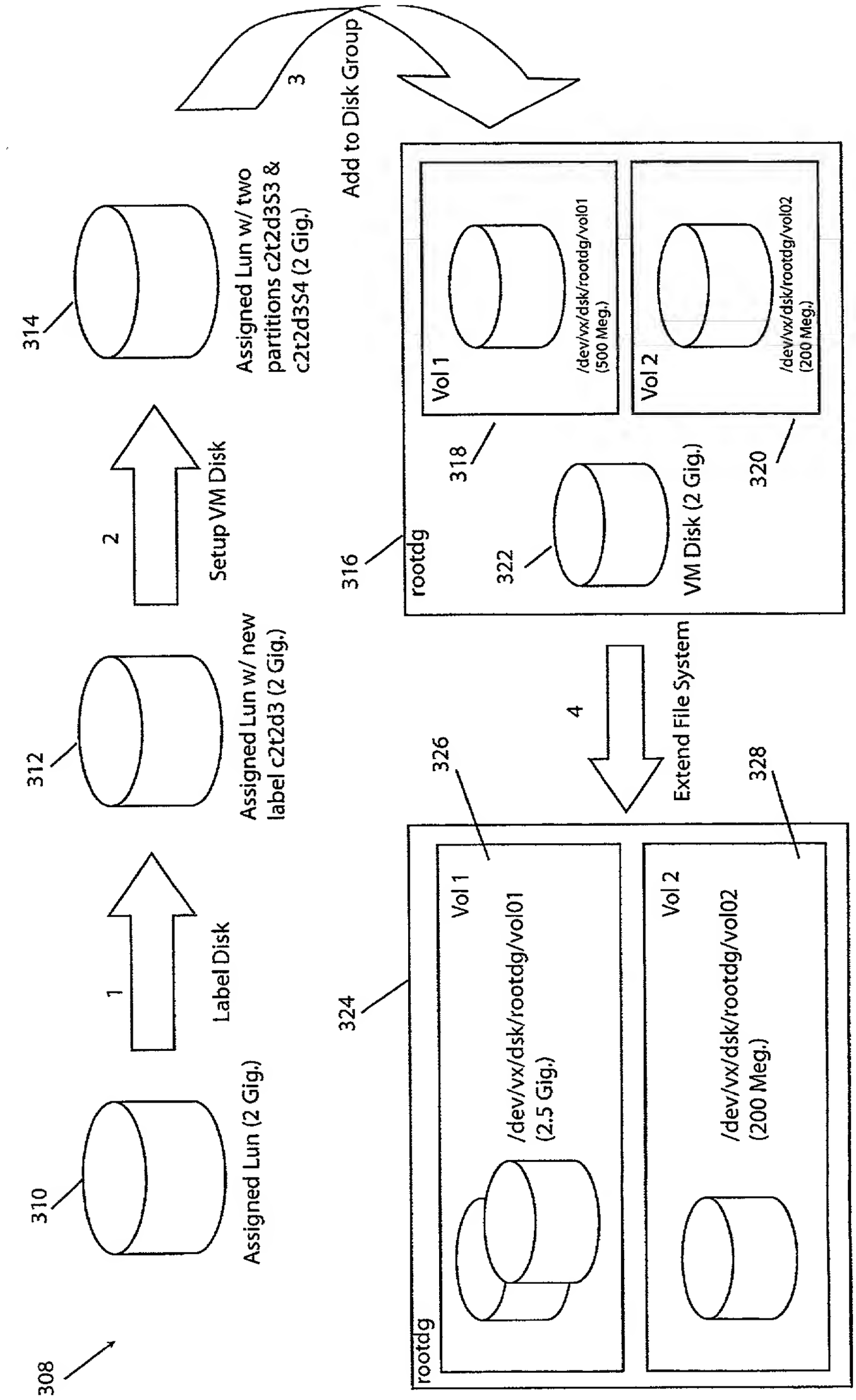

308
310
Assigned Lun (2 Gig.)
1
Label Disk
312
Assigned Lun w/ new label c2t2d3 (2 Gig.)
2
Setup VM Disk
314
Assigned Lun w/ two partitions c2t2d3S3 & c2t2d3S4 (2 Gig.)
3
Add to Disk Group
316
rootdg
318
Vol 1
/dev/vx/dsk/rootdg/vol01
(500 Meg.)
320
Vol 2
/dev/vx/dsk/rootdg/vol02
(200 Meg.)
322
VM Disk (2 Gig.)
4
Extend File System
324
rootdg
326
Vol 1
/dev/vx/dsk/rootdg/vol01
(2.5 Gig.)
328
Vol 2
/dev/vx/dsk/rootdg/vol02
(200 Meg.)

Figure 35

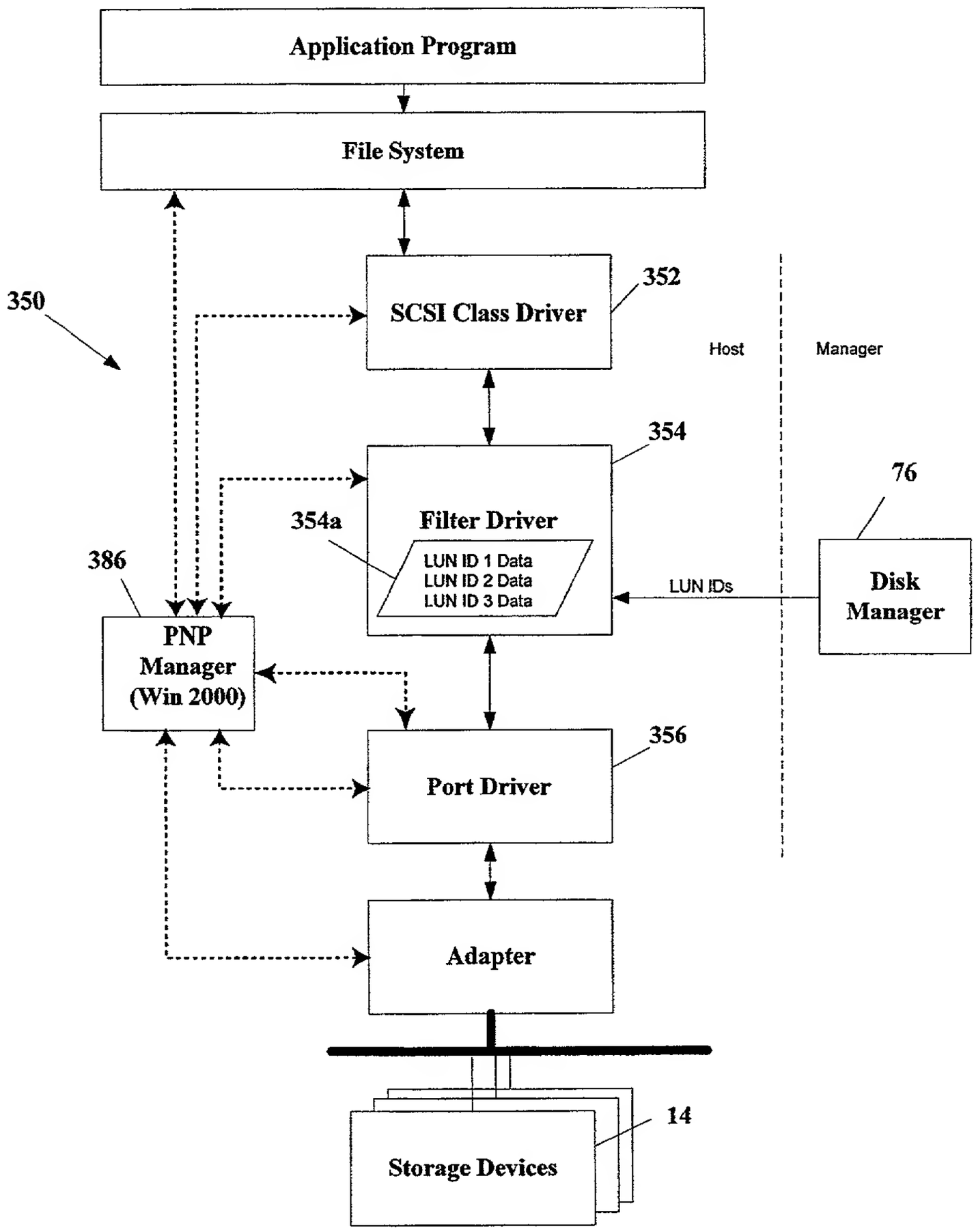

Application Program
File System
SCSI Class Driver
352
350
Host
Manager
354
Filter Driver
354a
LUN ID 1 Data
LUN ID 2 Data
LUN ID 3 Data
76
386
LUN IDs
Disk Manager
PNP Manager (Win 2000)
356
Port Driver
Adapter
14
Storage Devices

FIGURE 36

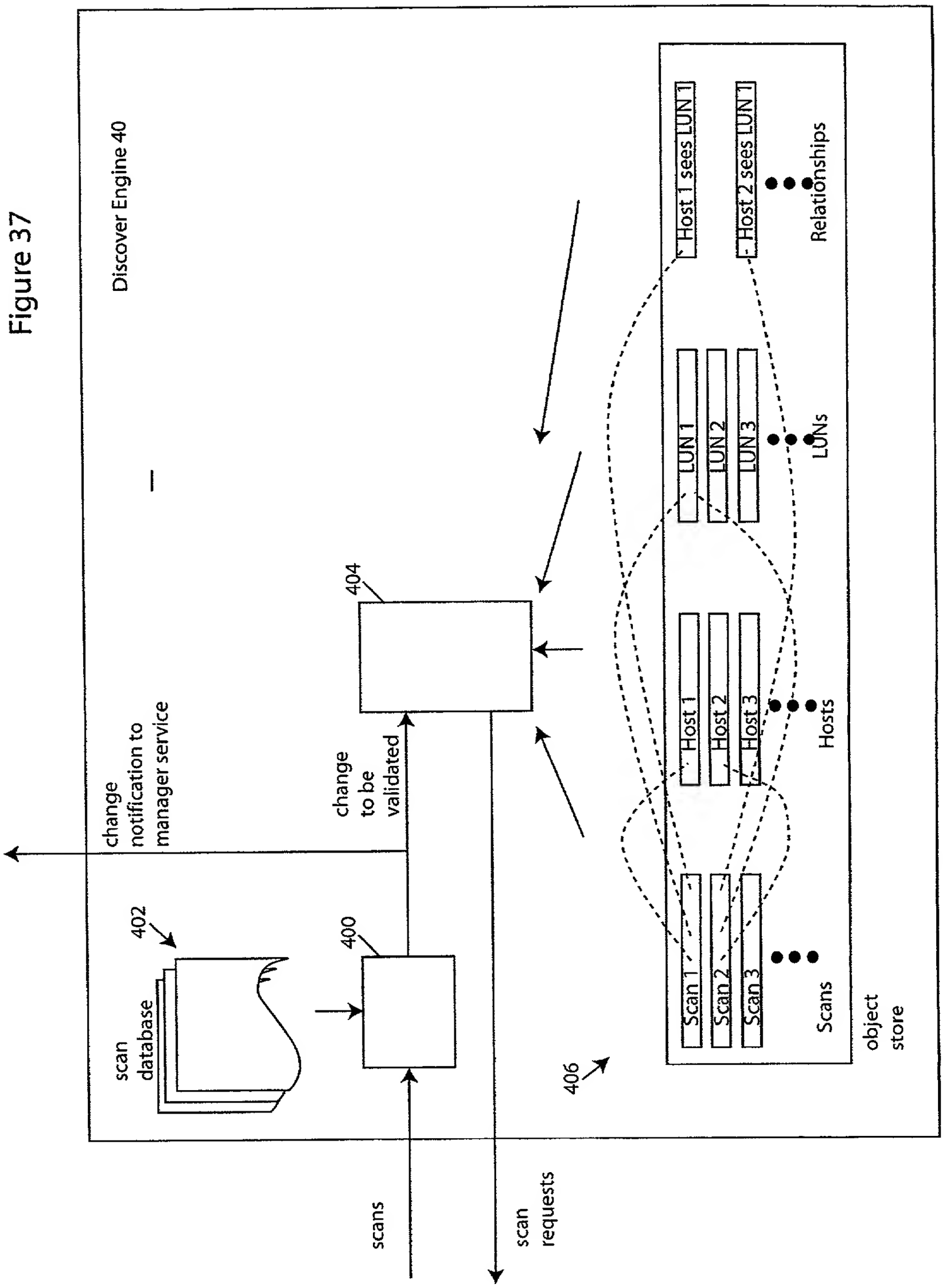

Discover Engine 40
change notification to manager service
change to be validated
scan database
402
400
404
406
Host 1 sees LUN 1
Host 2 sees LUN 1
Relationships
LUN 1
LUN 2
LUN 3
LUNs
Host 1
Host 2
Host 3
Hosts
Scan 1
Scan 2
Scan 3
Scans
object store
scans
scan requests

Figure 37

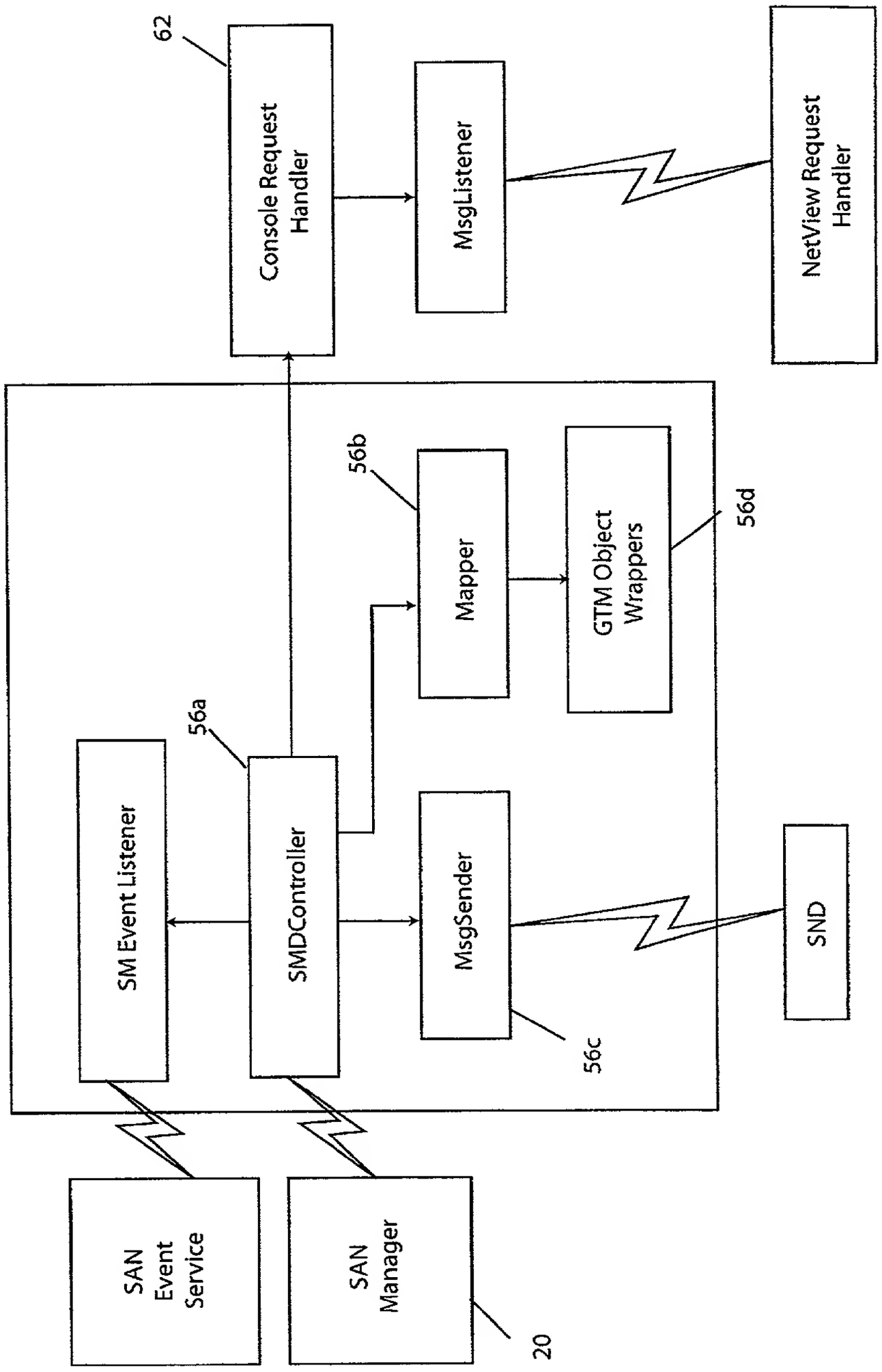

62
Console Request Handler
MsgListener
NetView Request Handler
56b
Mapper
GTM Object Wrappers
56d
56a
SMDController
SM Event Listener
MsgSender
56c
SND
SAN Event Service
SAN Manager
20

Figure 38

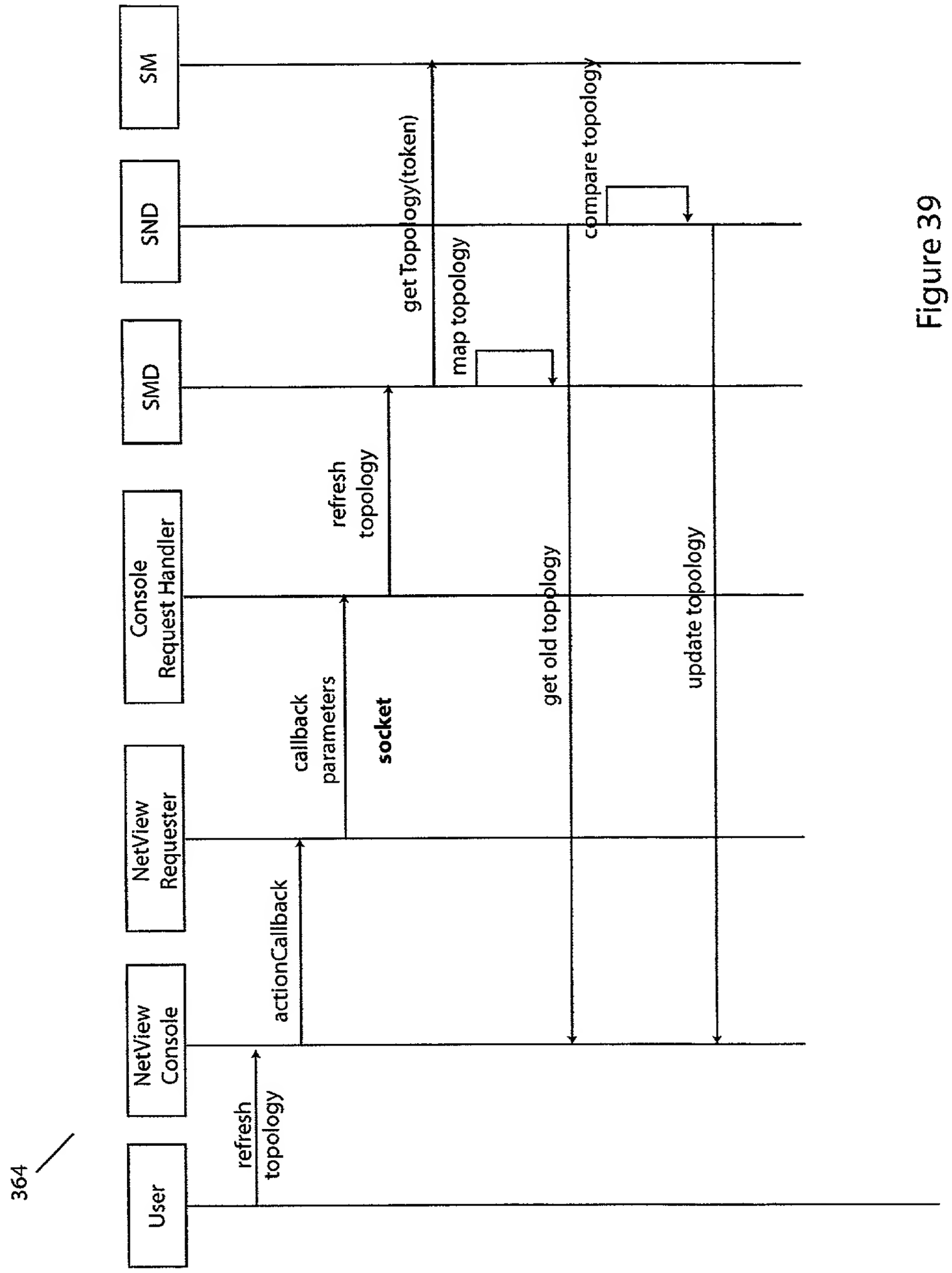

SM
SND
SMD
NetView Console
NetView Requester
Console Request Handler
User
364
get Topology(token)
compare topology
map topology
refresh topology
callback parameters
socket
get old topology
update topology
actionCallback
refresh topology

Figure 39

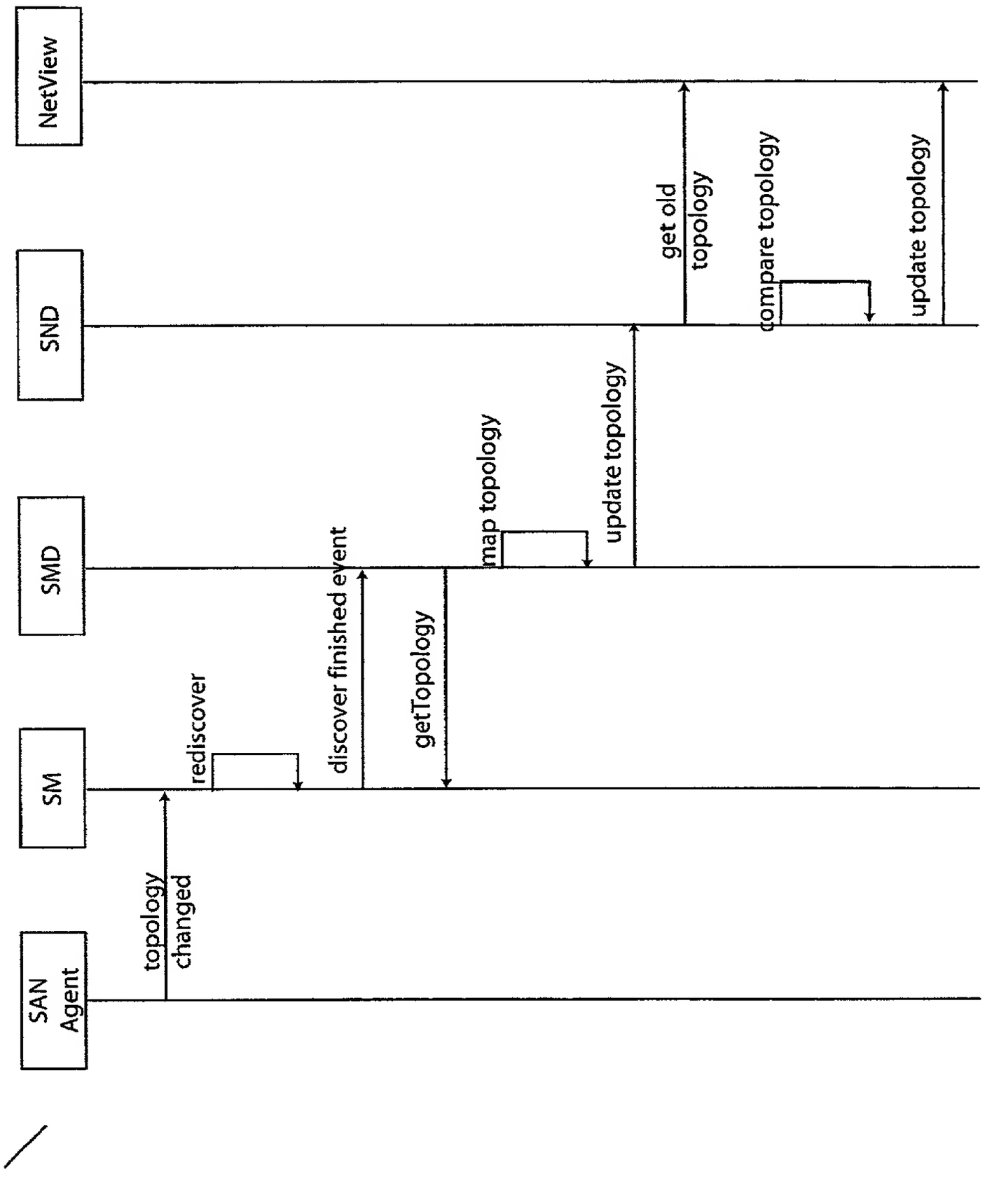

NetView
SND
SMD
SM
SAN Agent
get old topology
compare topology
update topology
map topology
update topology
rediscover
discover finished event
getTopology
topology changed
366

Figure 40

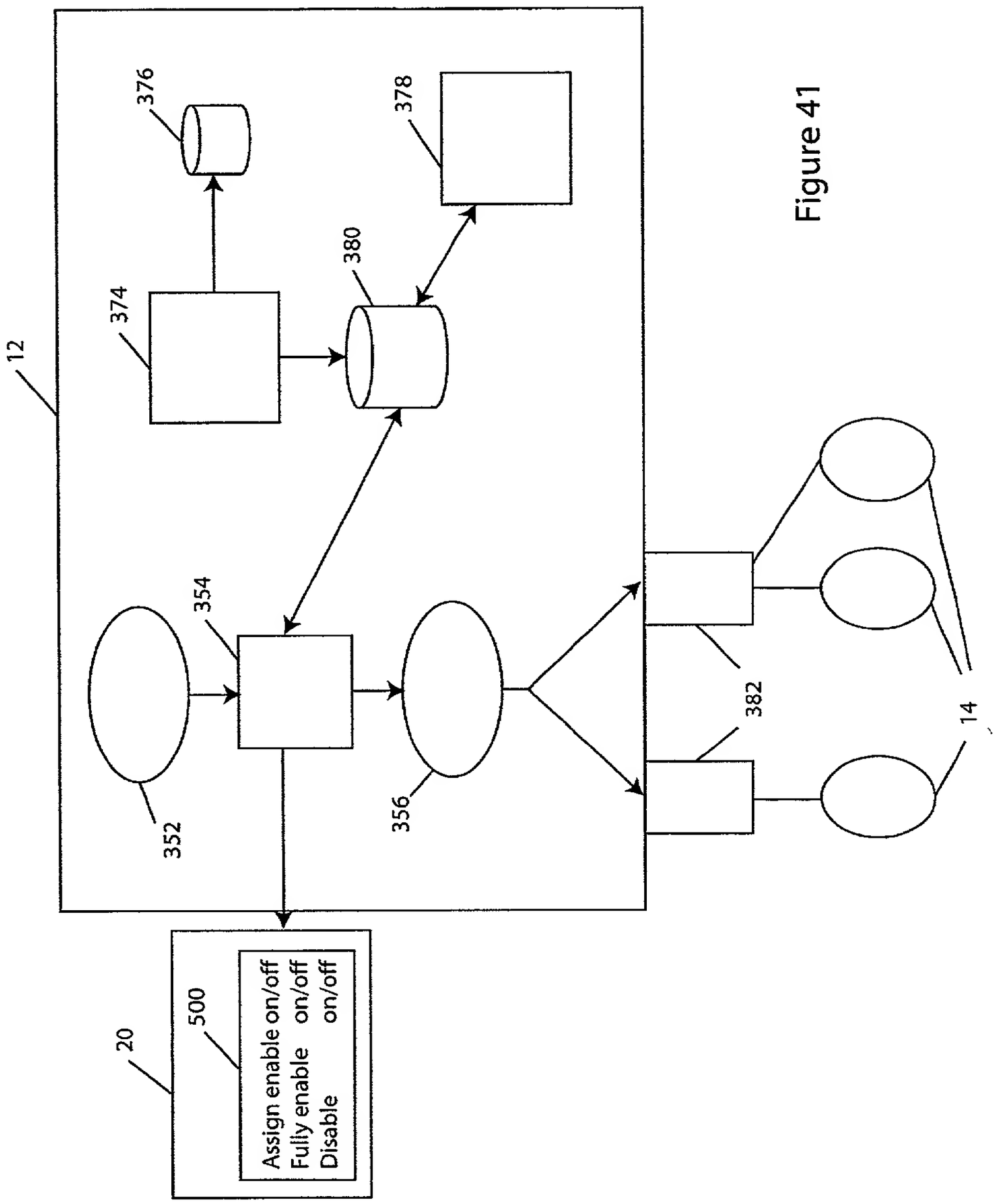

376
378
380
374
12
354
352
356
382
14
20
500
Assign enable on/off
Fully enable on/off
Disable on/off

Figure 41

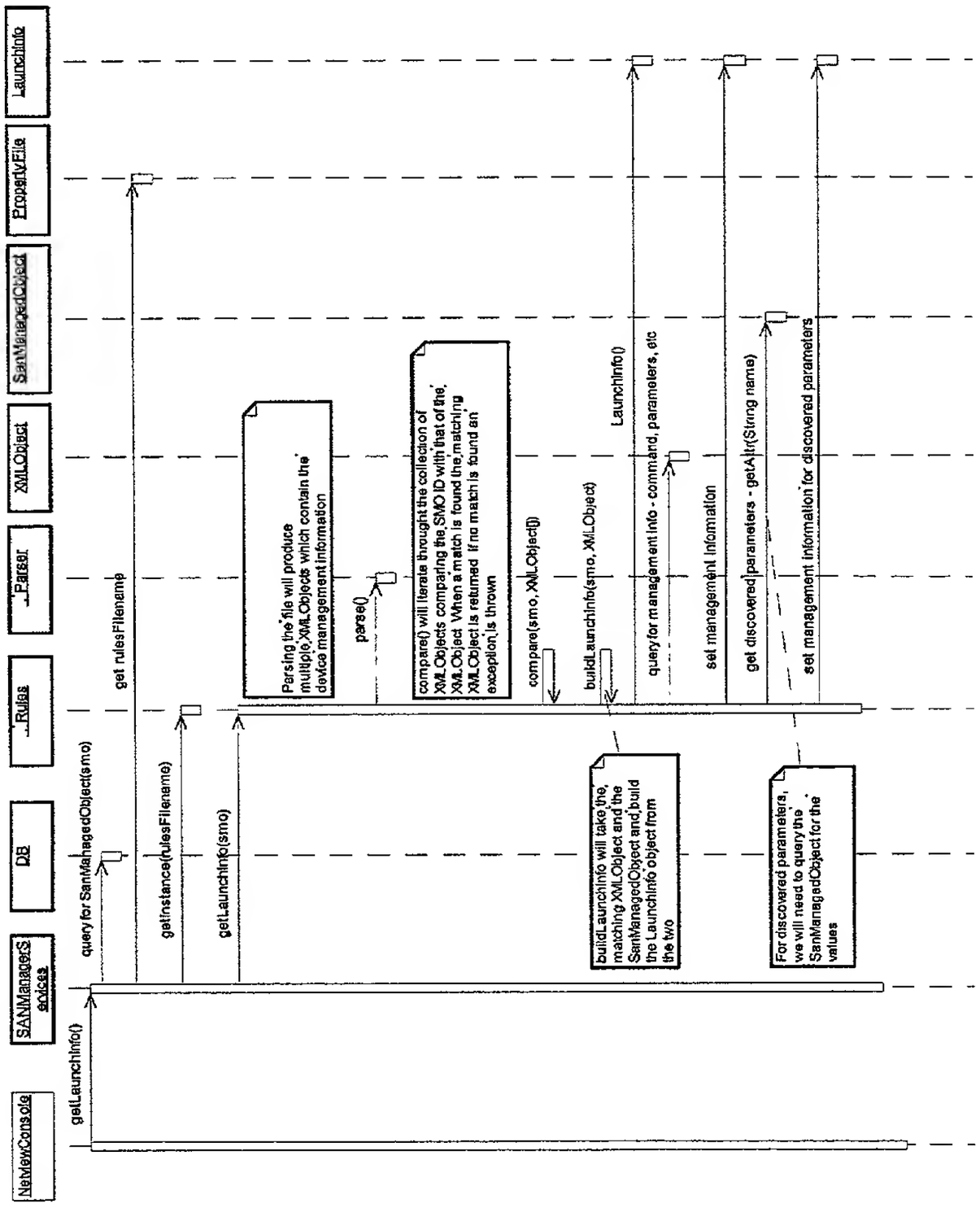

NetViewConsole
SANManagerS ervices
DB
Rules
Parser
XMLObject
SanManagedObject
LaunchInfo
PropertyFile
getLaunchInfo()
query for SanMahagedObject(smo)
getInstance(rulesFilename)
getLaunchInfo(smo)
get rulesFilename
Parsing the file will produce multiple XMLObjects which contain the device management information
parse()
compare() will literate throught the collection of XMLObjects comparing the SMO ID with that of the XMLObject When a match is found the matching XMLObject is returned If no match is found an exception is thrown
compare(smo, XMLObject)
buildLaunchInfo(smo, XMLObject)
LaunchInfo()
query for management info - command, parameters, etc
set management infomation
get discovered parameters - getAttr(String name)
set management information for discovered parameters
buildLaunchInfo will take the matching XMLObject and the SanManagedObject and build the LaunchInfo object from the two
For discovered parameters we will need to query the SanManagedObject for the values

Figure 42

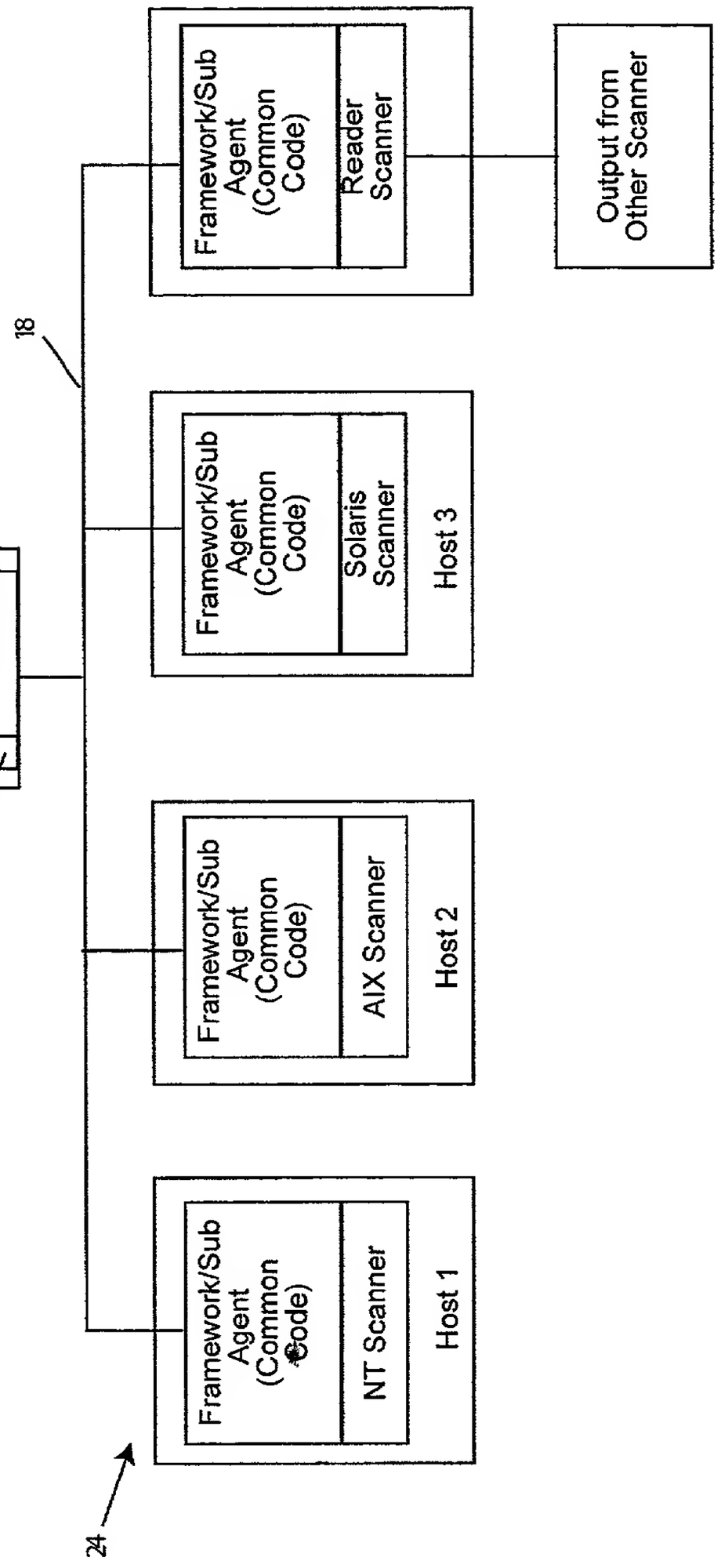

Framework/Sub Agent (Common Code)
Reader Scanner
Output from Other Scanner
18
SAN Manager
20
Query Engine
46
Comm. Srvc
510
512
Framework/Sub Agent (Common Code)
Solaris Scanner
Host 3
Framework/Sub Agent (Common Code)
AIX Scanner
Host 2
Framework/Sub Agent (Common Code)
NT Scanner
Host 1
24

Figure 43